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TENTH ANNUAL REPORT

OF THE

STATE GEOLOGIST,

FOR THE YEAR 1890.

TRANSMITTED TO THE LEGISLATURE JANUARY 31, 1891.

ALBANY:
JAMES B. LYON, STATE PRINTER.
1891.

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STATE OF NEW YORK.

No. 76.

IN SENATE,

JANUARY 31, 1891.

ANNUAL REPORT OF THE STATE GEOLOGIST.

OFFICE OF THE STATE GEOLOGIST,
ALBANY, *January* 31, 1891.

To the Legislature of the State of New York:

In pursuance of chapter 247 of the Laws of 1888, I have the honor to transmit to the Legislature the Tenth Annual Report of the State Geologist for the year 1890.

Very respectfully.

JAMES HALL,

State Geologist.

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REPORT.

To the Legislature of the State of New York:

GENTLEMEN.— During the past year, as in former years, since 1883, it has been necessary for the State Geologist to devote his time to the work of preparing and publishing the Palæontology of New York. Volume VIII, (Part I), is now in press, and far advanced toward completion, there being something more than 250 pages in type, and the manuscript prepared for the remainder of the volume as contemplated, to the completion of the Productidæ.

The lithographing of the plates is nearly completed, and this work will be finished before the 1st of January, 1891.

Much work has already been done in the preparation of Part II of this volume. Fifteen plates are already lithographed and drawings prepared, which will make at least six plates more for the second part of the volume. A large amount of material has been collected for study preparatory to the completion of this part of the volume, and the work on much of this material has been advanced so that it is in condition for immediate use.

The State Geologist has also given attention to the forwarding of other work which has been for some time in progress, and especially the Dictyospongidæ and Bryozoa. For the former work the collections have been increased, and some new forms obtained; and for the latter class of fossils, much work has been done preparatory to the completion of the Bulletin which was long since directed to be prepared, but for which no means have yet been provided.

Few opportunities have offered for increasing the collections of the Silurian Lamellibranchiata preparatory to completing the Bulletin on the "GENERA OF PALÆOZOIC LAMELLIBRANCHIATE SHELLS," for which ten plates were already lithographed nine years ago.

I can not but regard it a great misfortune to the reputation of the State Museum, and to its influence as an educating institution, that work already long since commenced, and progressed under

approval and direction of the Trustees, should be suspended indefinitely, while new work has been taken up and carried on to completion.

So long as the work on these groups of organisms can not be published, the subjects remain in mind, and it is quite impossible to drop them from consideration, and take up other work as if these had been completed or had never been commenced.

This condition prevents the conception, planning or forwarding of other work in the same direction, and for which there is great need in our education; and this is moreover a kind of work which the State of New York could easily supply for the benefit of her educators and those who are to be educated.

It is scarcely possible to estimate the loss to the reputation and prestige of the Museum and to the state which has come from the actual suspension of work in these branches for so many years; a loss which the most earnest devotion to that or similar work or publication, in the future, can never repair. Without dwelling further on this unhappy condition of certain departments of work relating to the Palæontology, I would earnestly ask for some positive and final action; even an adverse decision will be preferable to suspense.

The early months of the year were devoted to the supervision of the printing of Part I of volume VIII; the Brachiopoda Inarticulata. The discussions upon the genera of this order together with the descriptions of new species constitute the first 185 pages of the volume.

The scope of this volume is much wider than any of the preceding volumes on the Palæontology of New York, embracing, as proposed, a revision of the genera of the Palæozoic Brachiopoda, and therefore treating of the most numerous and most characteristic forms, as well as the most useful for the identification and determination of the comparative age of the older geological formations of the continent. To accomplish such a work requires the investigation of material from widely separated localities and from all the recognized subdivisions of the entire geological column. It has therefore been necessary to go outside of the limits of the state to obtain material for study, both from the older Palæozoic formations, which are but very meagerly represented in the collections of the State Museum, and also from the later Palæozoic strata which do not exist within the limits of

the State of New York. Moreover the extension of the New York formations beyond the limits of the state in the north, south and west directions, gives other forms than those found within its borders, and enlightens us in regard to the geographical distribution of genera and species, and the varying influences to which they may have been subjected in these wider areas of their original habitat.

The importance of carrying out such views has been recognized in the first part of the volume on the Inarticulate Brachiopods where several genera, known only in the older rocks of Canada, have been introduced and discussed. In the second part of the work, that upon the Articulate Brachiopods, this requirement became even more imperative, since a considerable number of genera and species had been described from the older rocks of Canada by Mr. Billings which had not been recognized elsewhere.

These forms moreover are very important as lying at the basis of our classification of the Articulate division of the Brachiopoda.

On the completion of the printing of Part I, before referred to, I visited the Redpath Museum at Montreal and the Museum of the Geological Survey at Ottawa for the purpose of studying certain imperfectly known forms, and of selecting specimens of such genera and species as would aid in the illustration of the volume in hand, according to its original plan.

Through the kindness of Sir William Dawson I was able to obtain, from the Redpath Museum, a considerable number of interesting forms for study and illustration. At Ottawa the Director of the Geological Survey, through Mr. J. F. Whiteaves, the Palæontologist, granted every possible facility and assistance for the study of the collections in the Museum of the survey, and I was permitted the loan of a large number of specimens for the study of species and genera long since described by Mr. Billings from the older geological formations. These species, in the progress of study of the Brachiopoda, during recent years, have become extremely interesting and important, as being the earliest forms exhibiting the incipience of certain types of structure which have become more fully developed in later geological periods. The collections thus obtained have been of the greatest importance in the preparation of the plates, the illustration and

discussion of the generic relations of the older forms among the Articulate Brachiopods, and in tracing the lineal descent of certain generic features from their earliest appearance in the Cambrian period.

In this connection I should also make my acknowledgments to Mr. Geo. F. Matthew of St. John for the loan of specimens, both of the inarticulate and articulate forms of Brachiopoda, represented in the genera ACROTHELE, ACROTRETA, LINGULELLA, LINNARSSONIA, KUTORGINA, and ORTHIS-PROTORTHIS, all from the Cambrian of New Brunswick. Also for his valuable notes and suggestions regarding some of the genera which will be fully acknowledged in the text of the volume.

After returning from Montreal and Ottawa I visited many of the public and private collections of Indiana, Illinois, Missouri and Kansas and obtained the loan of material which has been very useful in completing the illustrations and discussion of generic forms of the Carboniferous period.

I have been heretofore, in 1888, and am now again, indebted to the Trustees of the Illinois State Museum, through Dr. Lindahl, the Curator of the Museum for the loan, in the first instance, of their very fine collection of Spiriferoids. During the past summer Dr. Lindahl, at my request, has sent down to the State Hall, for use in the preparation and completion of volume VIII, the entire typical collection of ORTHIS, the streptorhynchoid forms under several genera, the CHONETES and PRODUCTUS from the Illinois State Museum. These have been of essential service in the progress of the work.

The University of Missouri granted me the privilege of selecting from their collections, for study and comparison, a series of specimens illustrating certain species described by Prof. Swallow while State Geologist of Missouri. These specimens have been of essential service in comparing species and of correcting erroneous views regarding certain genera and species current in the catalogues.

From the beginning of the work the Trustees of the American Museum of Natural History have granted the privilege of using such material in the collections of that institution as might be needed in the progress of this work on the Brachiopoda. This privilege has been of great advantage, since these collections contain the types and typical specimens of many of the genera of the

Palæozoic Brachiopoda, which were described more than twenty years since.

I may also in this place be permitted to make special acknowledgment to the following gentlemen for the loan of specimens from their private collections in aid of this work upon the Brachiopoda since its commencement in 1888.

In my first efforts to obtain specimens for the illustration of the volume I was indebted to Mr. Thomas A. Greene of Milwaukee for the loan of large collections of the Inarticulate Brachiopoda of the genera Trimerella, Monomerella, Dinobolus, etc., from the Niagara group of Milwaukee and adjacent localities, which have been used in the discussion of certain genera and are illustrated upon the plates of the volume. He has also loaned from his collection of Silurian Articulate Brachiopoda specimens of the genera Orthis, Orthotetes, Leptæna, Strophodonta, Rafinesquina, Spirifer, Pentamerus, Rhynchonella, and several Athyroid genera, etc., for use in the second part of the volume.

To Prof. J. S. Newberry, of Columbia College, for specimens of Orthis, Athyris, Spirifer, Pentamerus, Rhynchonella and Camarella from the Silurian; Rhynchonella, Leiorhynchus and Meristella from the Devonian; and of Lingula, Orbiculoidea, Orthis, Enteletes, Derbya, Productus, Spirifer, Syringothyris, Athyris and Dielasma from the Carboniferous.

To Prof. J. M. Safford, State Geologist of Tennessee, I am under obligations for the loan of a very important collection of Orthids, representing several little known Lower Silurian species; also for an interesting collection of Scenidium from the same geological horizon.

To Prof. Edward Orton, State Geologist of Ohio, I am indebted for specimens of Lingula, Orbiculoidea and Trimerella of the Inarticulate Brachiopods and of Orthis, Strophomena, Triplecia, Meristella, Spiriferina, etc., from the Silurian and Carboniferous formations.

To Prof. C. S. Herrick, of Denison University, now of the University of Cincinnati, for specimens of Orbiculoidea, Orthis, Spirifera, Spiriferina, and Syringothyris from the Waverly group of Ohio.

To Prof. J. P. Lesley, State Geologist of Penna., for specimens of Orbiculoidea of the Devonian.

To Prof. G. C. Broadhead, of the University of Missouri, for specimens of Enteletes, Chonetes, Derbya and Productus from the Upper Coal Measures.

To Prof. J. R. Eaton, of William Jewell College, Liberty, Mo., for specimens of a remarkable form of Productus from the Upper Carboniferous limestone.

To Chas. D. Walcott, of the United States Geological Survey, for Orthis-Protorthis of the Cambrian.

To Prof. S. Calvin, of the University of Iowa for specimens of Spirifer, Stricklandinia, Pentamerus, Orthis, Strophonella, Chonetes, Enteletes and Derbya from the Silurian, Devonian and Carboniferous formations.

To the Rev. H. Herzer, of Berea, Ohio, for Lingula and Orbiculoidea of the Waverly group.

To Dr. C. Rominger, of Ann Arbor, Mich., for Chonetes, Derbya and Productus of the upper Carboniferous.

To Prof. E. W. Claypole, of Buchtel College, Akron, Ohio, for specimens of Lingula from the Waverly group.

To President E. S. Brainerd and Prof. Henry M. Seeley, of Middlebury College, Middlebury, Vt., for specimens of Orthis, Triplecia and other fossils from the Calciferous beds at Fort Cassin, Vermont.

To Prof. G. H. Perkins, of the University of Vermont, Burlington, Vt., for specimens of Orthis, Triplecia, etc., from the Calciferous beds of Fort Cassin, Vermont.

To Mr. W. C. Egan, of Chicago, Brachiopoda of the Niagara group, and Spirifera, Athyris, Enteletes, etc., from the Carboniferous.

To Mr. E. E. Teller, of Milwaukee, Wis., specimens of *Spirifera radiata* and *Spirifera nobilis* of the Niagara group.

To Mr. F. A. Sampson, of Sedalia, Mo., specimens of Orbiculoidea from the Choteau limestone and Coal Measures.

To Mr. F. A. Blair, Commissioner of the Geological Survey of Missouri, Sedalia, Mo., a collection of Brachiopoda, Lamellibranchiata, etc., from the Choteau group; donated to the Museum.

To Rev. John Bennett, of Kansas City, Kansas, for the loan of specimens of Derbya, Productus, Enteletes, etc., from the Upper Coal Measures.

To Mr. Wm. H. R. Lykins, of Kansas City, Mo., Orbiculoidea, Productus, Aulocorhynchus, etc., from the Upper Coal Measures.

To Mr. S. J. Hare, of Kansas City, Mo., for specimens of Orbiculoidea, Derbya, Productus, Spirifera, etc., from the Upper Coal Measures.

To Mr. F. W. McIntosh, of Kansas City, Mo., specimens of Productus from the Upper Coal Measures.

To Prof. Joseph Moore, of Earlham College, Richmond, Ind., a new species of Pentamerus, Strophomena, etc., from the Silurian.

To Mr. Walter R. Billings, of Ottawa, Ontario, Can., specimens of Lingula, Elkania, Obolella, Orthisina, Camerella, Zygospira of the Cambrian and Silurian.

To Mr. B. E. Walker, of Toronto, Ontario, Can., specimens of Orbiculoidea, *Orthis flabellum*, Stricklandinia of the Niagara.

To Col. C. C. Grant, of Hamilton, Ontario, Can., specimens of Orbiculoidea.

To Prof. Thomas Stowell, of Potsdam, N. Y., specimens of Lingula, Orbiculoidea, Orthostrophia, Strophonella, and Strophodonta from the Silurian and Devonian.

To Prof. W. L. Brownell, Syracuse, N. Y., specimens of Triplecia of the Trenton limestone, and other fossils.

To Mr. E. B. Knapp, of Skaneateles, N. Y., specimens of Orthis, Rhynchonella and other fossils from the Tully limestone.

To Mr. D. S. Chatfield, of Syracuse, N. Y., a numerous collection of Athyris, Spirifera, Trematospira, Leiorhynchus, Rhynchonella and other fossils, principally of Devonian and Carboniferous age.

I have elsewhere written that almost at the commencement of this work I secured the services of Mr. Charles Schuchert, as private assistant, with the privilege of having the use of his extensive collection of Brachiopoda, in the preparation of this volume, while his knowledge of this class of fossils has been made available in many ways in the advancement of the work.

In the progress of the work on volume VIII, *one hundred and fifty-four* genera of the Brachiopoda have been discussed in 325 pages of text and illustrated on forty-one lithographic plates leaving one hundred and six to be treated in the second part of the volume. This latter number will be somewhat increased by the necessity for subdividing some of the groups now included under a single generic name. I have herewith communicated a list of all recognized genera which have been already studied and now form a part of the volume which is nearly completed. This list is so arranged that the comparative value of each term is expressed in the character of the type used, as explained in a prefatory note.

The Genera of Brachiopoda still requiring final study and revision, especially in some of the groups, are given in a separate list following the first and in uniform type, therefore expressing no opinion regarding their comparative value.

It may however be proper for me to state in this place that for the illustration of the genera included in this list there are

already fifteen plates lithographed and printed to the number of 3,000 copies of each, and one plate not printed. There are also original drawings to the number of more than three hundred figures, showing that the work of illustration is very far advanced.

It is undoubtedly true that the most difficult part of the entire work has been accomplished viz.: that upon the Brachiopoda Inarticulata entire, and also that upon the earlier Articulates of the Primordial or of the Cambrian and Lower Silurian faunas, leaving the remaining work to be done among groups which are less obscure and their relations and already better understood than were those of the earlier types of this division of the Brachiopoda.

I.

THE GENERA OF THE PALÆOZOIC BRACHIOPODA.

[During the progress of the work preparatory for volume VIII of the Palæontology of New York it became evident that any attempt at a classification of the genera into families would become extremely embarrassing, and of no permanent value. This fact was altogether due to the progress of our knowledge during the past twenty-five years and to the comparative completeness of the material under examination, which was sufficient to show that the accepted subdivisions required important modifications before any satisfactory order could be brought out. For these reasons it was deemed wiser to defer any such attempt and reserve the discussions of the mutual relations of the genera for separate chapters. The palæozoic genera of the Brachiopoda Inarticulata entire, and of the genera of the Articulata in part, from Orthis to Productus inclusive, in that line of arrangement, have been finally reviewed in accordance with the following list, as far as the names in heavy-faced type extend, and this part of the list, therefore represents the order of treatment and to some extent the present understanding of the value of these genera.

All non-binomial or pra'e-Linnean terms are omitted.

Terms which are recognized, but with a subordinate value, are inset, while undoubted synonyms are in italics.]

I. Brachiopoda Inarticulata.

1. **Lingula**, Bruguière, 1789.
2. **Dignomia**, Hall, 1871.
3. **Glossina**, Phillips, 1848.
4. *Pharetra*, Bolten, 1798.
5. *Lingularius*, Duméril, 1806.
6. **Lingulops**, Hall, 1871.
7. **Lingulasma**, Ulrich, 1889.
8. **Lakhmina**, Œhlert, 1887.
9. *Davidsonella*, Waagen, 1885.
10. **Trimerella**, Billings, 1862.
11. *Gotlandia*, Dall, 1870.
12. **Dinobolus**, Hall, 1871.
13. (*Conradia*, Hall, MS., 1862.)
14. *Obolellina*, Billings, (*partim*), 1871.
15. **Monomerella**, Billings, 1871.
16. **Rhinobolus**, Hall, 1871.
17. **Lingulella**, Salter, 1866.
18. **Lingulepis**, Hall, 1863.
19. **Barroisella**, gen. nov.
20. **Tomasina**, gen. nov.
21. **Obolella**, Billings, 1861.

22. **Leptobolus**, Hall, 1871.
23. **Elkania**, Ford, 1886.
24. *Billingsia*, Ford, 1886.
25. **Paterula**, Barrande, 1879.
26. **Obolus**, Eichwald, 1829.
27. *Ungula*, Pander, 1830.
28. *Ungulites*, Bronn, 1848.
29. *Aulonotreta*, Kutorga (*partim*), 1848.
30. **Aulonotreta**, Kutorga, 1848.
31. *Acritis*, Volborth, 1869.
32. **Schmidtia**, Volborth, 1869.
33. **Monobolina**, Salter, 1865.
34. **Neobolus**, Waagen, 1885.
35. **Spondylobolus**, McCoy, 1852.
36. **Mickwitzia**, Schmidt, 1888.
37. **Schizobolus**, Ulrich, 1886.
38. **Discinolepis**, Waagen, 1885.
39. **Kutorgina**, Billings, 1861.
40. **Schizopholis**, Waagen, 1885.
41. **Volborthia**, von Möller, 1873.
42. **Iphidea**, Billings, 1872.
43. **Acrothele**, Linnarsson, 1876.
44. **Acrotreta**, Kutorga, 1848.
45. **Conotreta**, Walcott, 1889.
46. **Discinopsis**, gen. nov. (Matthew).
47. **Linnarssonia**, Walcott, 1885.
48. **Mesotreta**, Kutorga, 1848.
49. **Siphonotreta**, de Verneuil, 1845.
50. **Schizambon**, Walcott, 1884.
51. **Keyserlingia**, Pander, 1861.
52. **Helmersenia**, Pander, 1861.
53. **Orbiculoidea**, d'Orbigny, 1847.
54. *Discina*, auctorum, non Lamarck, 1819.
55. *Orbicula*, auctorum, non Sowerby, 1822.
56. **Schizotreta**, Kutorga, 1848.
57. *Orbiculoidea*, Davidson, 1856.
58. **Lindstrœmella**, sub-gen. nov.
59. **Œhlertella**, sub-gen. nov.
60. *Lingulodiscina*, Whitfield, 1890.
61. **Rœmerella**, sub-gen. nov,
62. **Trematis**, Sharpe, 1847.
63. *Orbicella*, d'Orbigny, 1847.
64. **Schizocrania**, Hall and Whitfield, 1875.
65. **Crania**, Retzius, 1781.
66. *Anomia*, Linné, 1760 (*partim*).
67. *Ostracites*, Beuth, 1776.
68. *Patella*, Müller, 1776.
69. *Numulus*, Waller, 1778.
70. *Criopus*, Poli, 1791.
71. *Criopoderma*, Poli, 1795.
72. *Orbicula*, Cuvier, 1798.
73. *Orbicularius*, Duméril, 1806.
74. *Craniolites*, Schlotheim, 1820.
75. *Choniopora*, Schauroth, 1854.
76. **Pseudocrania**, McCoy, 1851.
77. *Palœocrania*, Eichwald, 1860.
78. **Craniella**, Œhlert, 1888.
79. **Cardinocrania**, Waagen, 1885.
80. **Pholidops**, Hall, 1859.
81. *Patellites*, Schlotheim, 1820.
82. *Craniops*, Hall, 1859.

II. Brachiopoda Articulata.

83. **Orthis**, Dalman, 1828.
84. **Orthis** sensustricto.
85. *Orthambonites*, Pander, 1830.
86. **Hebertella**, sub-gen. nov.
87. **Plectorthis**, sub-gen. nov.
88. **Mystilea**, sub-gen. nov.
89. **Plæsiomys**, sub-gen. nov.
90. **Orthostrophia**, Hall, 1883.
91. **Platystrophia**, King, 1850.
92. **Heterorthis**, sub-gen. nov.
93. **Bilobites**, Linné, 1775.
94. *Dicœlosia*, King, 1850.
95. **Dalmanella**, sub-gen nov.
96. **Rhipidomella**, Œhlert, 1890.
97. *Rhipidomys*, Œhlert, 1887.
98. **Schizophoria**, King, 1850.
99. **Orthotichia**, sub-gen. nov.
100. **Enteletes**, Fischer de Waldheim, 1830.

101. **Syntrielasma**, Meek and Worthen, 1865.
102. **Protorthis**, gen. nov.
103. **Billingsella**, gen. nov.
104. **Scenidium**, Hall, 1860.
105. *Mystrophora*, Kayser, 1871.
106. **Clitambonites**, Pander, 1830.
107. *Pronites*, Pander, 1830.
108. *Gonambonites*, Pander, 1830.
109. **Hemipronites**, Pander, 1830.
110. **Orthisina**, d'Orbigny, 1847.
111. **Polytœchia**, sub-gen. nov.
112. **Orthidium**, gen. nov.
113. **Strophomena**, Rafinesque, 1825.
114. **Orthothetes**. Fischer de Waldheim, 1829.
115. **Hipparionyx**, Vanuxem, 1842.
116. **Derbya**, Waagen, 1884.
117. **Kayserella**, gen. nov.
118.
119. **Meekella**. White and St. John, 1868.
120. **Streptorhynchus**, King, 1850.
121. **Triplecia**, Hall, 1859.
122. *Dicraniscus*, Meek, 1872.
123. **Mimulus**, Barrande, 1879.
124. **Streptis**, Davidson, 1881.
125. **Leptella**, gen. nov.
126. **Leptænulopsis**, Haupt, 1878.
127. **Leptæna**, Dalman, 1828.
128. *Leptagonia*, McCoy, 1844.
129. **Rafinesquina**, gen. nov.
130. **Strophodonta**, Hall, 1850.
131. **Douvillina**, Œhlert, 1887.
132. **Brachyprion**, Shaler, 1865.
133. **Leptostrophia**, sub-gen. nov.
134. **Amphistrophia**, sub-gen. nov.
135. **Strophonella**, Hall, 1879.
136. **Plectambonites**, Pander, 1830.
137. *Leptœna*, Davidson, 1856.
138. **Christiania**, gen. nov.
139. **Davidsonia**, Bouchard, 1849.
140. **Leptænisca**, Beecher, 1890.
141. **Chonetes**, Fischer de Waldheim.
142. **Chonetina**, Krotow, 1888.
143. **Anoplia**, gen. nov.
144. **Chonostrophia**, gen. nov.
145. **Chonopectus**, gen. nov.
146. **Chonetella**, Waagen, 1884.
147. **Daviesiella**, Waagen, 1884.
148. **Strophalosia**, King, 1844.
149. *Leptœnalosia*, King, 1845.
150. *Orthrothrix*, Geinitz, 1847.
151. **Aulosteges**, von Helmersen, 1847.
152. **Productus**, Sowerby, 1812.
153. **Productella**, Hall, 1867.
154. **Marginifera**, Waagen, 1884.
155. **Proboscidea**, Œhlert, 1887.
156. **Etheridgina**, Œhlert, 1887.

[The genera in the remainder of this list have not yet been critically studied. It is therefore not the intention to express the respective values of the terms given below. The list will serve to indicate the amount of work still necessary to complete the revision of the palæozoic genera of Brachiopoda.]

157. Eichwaldia, Billings, 1858.
158. Dictyonella, Hall (MS.), 1867.
159. Aulacorhynchus, Dittmar, 1872.
160. Isogramma, Meek and Worthen, 1873.
161. Spirifer, Sowerby, 1815.
162. Trigonotreta, König, 1825.
163. Choristites, Fischer de Waldheim, 1825.
164. Fusella, McCoy, 1844.
165. Brachythyris, McCoy, 1844.
166. Martinia, McCoy, 1844.
167. Reticularia, McCoy, 1844.
168. Delthyris, Dalman, 1828.
169. Martiniopsis, Waagen, 1883.
170. Ambocœlia, Hall, 1860.
171. Spiriferina, d'Orbigny, 1847.
172. Mentzelea, Quenstedt, 1871.
173. Cyrtia, Dalman, 1828.
174. Cyrtina, Davidson, 1858.
175. Syringothyris, Winchell, 1863.
176. Athyris, McCoy, 1844.
177. Spirigera, d'Orbigny, 1847.
178. Seminula, McCoy, 1844.

179. Actinoconchus, McCoy, 1844.
180. Euthyris, Quenstedt, 1871.
181. Cleiothyris, King, 1850.
182. Spirigerella, Waagen, 1883.
183. Kayseria, Davidson, 1882.
184. Merista, Suess, 1851.
185. Camarium, Hall, 1859.
186. Meristella, Hall, 1860.
187. Meristina, Hall, 1867.
188. Charionella, Billings, 1861.
189. Whitfieldia, Davidson, 1882.
190. Pentagonia, Cozzens, 1846.
191. Goniocoelia, Hall, 1861.
192. Bifida, Davidson, 1882.
193. Nucleospira, Hall, 1859.
194. Retzia, King, 1850.
195. Rhynchospira, Hall, 1859.
196. Trematospira, Hall, 1857.
197. Acambona, White, 1864.
198. Eumetria, Hall, 1864.
199. Trigeria, Bayle, 1878.
200. Uncites, Defrance, 1825.
201. Uncinella, Waagen, 1883.
202. Dayia, Davidson, 1881.
203. Hindella, Davidson, 1882.
204. Atrypa, Dalman, 1828.
205. Spirigerina, d'Oribgny, 1847.
206. Zygospira, Hall, 1862.
207. Orthonomæa, Hall, 1858.
08. Stenoschisma, Hall, 1847 = of Conrad.
209. Cœlospira, Hall, 1863.
210. Glassia, Davidson, 1882.
211. Anazyga, Davidson, 1882.
212. Grünewaldtia, Tschernyschew, 1885.
213. Karpinskia, Tschernyschew, 1885.
214. Anoplotheca, Sandberger, 1856.
215. Rhynchonella, Fischer de Waldheim, 1809.
216. Cyclothyris, McCoy, 1844.
217. Hypothyris, Phillips, 1841.
218. Wilsonia, Quenstedt, 1871.
219. Uncinulus, Bayle, 1878.
220. Terebratuloidea, Waagen, 1883.
221. Rhynchotrema, Hall, 1860.
222. Stenoschisma, Hall, 1867.
223. Rhynchopora, King, 1856.
224. Rhynchoporina, Œhlert, 1887.
225. Rhychotreta, Hall, 1879.
226. Eatonia, Hall, 1857.
227. Liorhynchus, Hall, 1860.
228. Conchidium, Linné, 1760.
229. Pentamerus, Sowerby, 1813.
230. Gypidia, Dalman, 1828.
231. Gypidula, Hall, 1867.
232. Branconia, Gagel, 1890.
233. Zdimir, Barrande, 1881.
234. Sieberella, Œhlert, 1887.
235. Antirhynchonella, Quenstedt, 1871.
236. Pentamerella, Hall, 1867.
237. Stenoschisma, Conrad, 1839.
238. Camarophoria, King, 1845.
239. Anastrophia, Hall, 1867.
240. Brachymerus, Shaler, 1865.
241. Camarella, Billings, 1859.
242. Stricklandia, Billings, 1859.
243. Stricklandinia, Billings, 1863.
244. Amphigenia, Hall, 1867.
245. Clorinda, Barrande, 1879.
246. Lycophoria, Lahusen, 1885.
247. Porambonites, Pander, 1830.
248. Isorhynchus, King, 1850.
249. Richthofenia, Kayser, 1881.
250. Lyttonia, Waagen, 1883.
251. Oldhamina, Waagen, 1883.
252. Stringocephalus, Defrance, 1827.
253. Terebratula, Müller, 1776.
254. Dielasma, King, 1850.
255. Epithyris, King, 1850.
256. Waldheimia, King, 1850.
257. Magellania, Bayle, 1880.
258. Cryptacanthia, White and St. John.
259. Eudesia, King, 1850.
260. Hemiptychina, Waagen, 1883.
261. Centronella, Billings, 1859.
262. Cryptonella, Hall, 1861.
263. Renssellæria, Hall, 1859.
264. Renssellandia Hall, 1867.
265. Megalanteris, Suess, 1856.
266. Newberria, Hall, 1891.
267. Leptocœlia Hall, 1857.
268. Tropidoleptus Hall, 1857.
269. Vitulina, Hall, 1860.

I.

ORIGINAL DRAWINGS FOR THE PALÆONTOLOGY OF NEW YORK, VOLUME VIII.

In order that full credit may be given to the several artists who have contributed to the illustration of the volume, the following explanation of the source of the figures is given. Since this work was commenced many years ago important changes have occurred in the organization then existing, and not a single draughtsman has been continued from the commencement. Some of the drawings especially of the Productidæ and others were made by Mr. F. B. Meek*, and his work was followed by that of Mr. R. P. Whitfield. As these plates were printed the name of the person who had done the greatest number of figures was usually given at the bottom of the plate as delineator.† In some cases it may be possible that equal justice has not been done. In order to meet this question and to do equal and exact justice to every one who has contributed to this work the following list of figures and their authors has been compiled. In the explanations of the Plates of the Brachiopoda Articulata, beginning with Plate V, the name of the author of each original drawing will be given.

PALÆONTOLOGY OF NEW YORK, VOLUME VIII.

LIST OF FIGURES UPON THE LITHOGRAPHIC PLATES ACCOMPANYING PART I OF VOL. VIII BRACHIOPODA INARTICULATA, WITH THEIR AUTHORSHIP.

[On the pages of explanations accompanying the plates to the second part of this work, upon the BRACHIOPODA ARTICULATA, a statement is given of the authorship of each one of the original drawings; the name appearing at the bottom of the plate as delineator being that of the draughtsman to whom the largest number of drawings is to be credited. These statements in detail were not given on the explanations of the plates in Part I and are hence inserted here. All the plates for this part of the work have been drawn on stone by Mr. PHILIP AST.]

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* Originally for the Report on the Geological Survey of Iowa.

† By arrangement among the draughtsmen themselves.

PLATE I.

Figs. 1–20. E. EMMONS.
21–22. Copies.
23. E. EMMONS.
24. R. P. WHITFIELD*.
Figs. 25–30. E. EMMONS.
31. Copy.
32–34. E. EMMONS.
35–36. R. P. WHITFIELD.

PLATE II.

Figs. 1–8. E. EMMONS.
9–13. R. P. WHITFIELD.
14–30. E. EMMONS.
31–33. R. P. WHITFIELD.
34–36. E. EMMONS.
Figs. 37. R. P. WHITFIELD.
38–39. E. EMMONS.
40–41. R. P. WHITFIELD.
42–44. E. EMMONS.

PLATE III.

Figs. 1, 2. E. EMMONS.
3. R. P. WHITFIELD.
4–6. E. EMMONS.
7. R. P. WHITFIELD.
8–10. E. EMMONS.
Figs. 11. R. P. WHITFIELD.
12. E. EMMONS.
13. R. P. WHITFIELD.
14–44. E. EMMONS.

PLATE IV.

Figs. 1–5. Copies.
6–9. E. EMMONS.
10, 11. R. P. WHITFIELD.
12–15. E. EMMONS.
16. R. P. WHITFIELD.
Figs. 17–20. E. EMMONS.
21–26. Copies.
27–30. E. EMMONS.
31. Copy.
32–38. E. EMMONS.

PLATE IV*a*.

Figs. 1, 2. E. EMMONS.
3. J. M. CLARKE.
4–6. E. EMMONS.
Figs. 7–9. R. P. WHITFIELD.
10. E. EMMONS.

PLATE IV*b*.

Figs. 1. E. EMMONS.
2–5. R. P. WHITFIELD.
6. J. M. CLARKE.
7. R. P. WHITFIELD.
8. J. M. CLARKE.
9. E. EMMONS.
Figs. 10, 11. J. M. CLARKE.
12–15. E. EMMONS.
16–20. R. P. WHITFIELD.
21. J. M. CLARKE.
23–25. E. EMMONS.

PLATE IV*c*.

Figs. 1–15. E. EMMONS.
16. J. M. CLARKE.
Figs. 17, 18. E. EMMONS.

* The drawings credited to Mr. Whitfield, both in the Brachiopoda Inarticulata and the Brachiopoda Articulata, were all done by him in the early preparation for this volume between 1868 and 1875. Some of the figures used, however, are from drawings of older date and have appeared in previous works of the author.

PLATE IV*d*.

Figs. 1–6. E. EMMONS.
7. J. M. CLARKE.
8–15. E. EMMONS.

PLATE IV*e*.

Figs. 1, 2. E. EMMONS.
3. Copy.
4–7. E. EMMONS.
8. Copy.
9. R. P. WHITFIELD.
10, 11. E. EMMONS.
12. R. P. WHITFIELD.
13, 14. E. EMMONS.
15–18. R. P. WHITFIELD.
19–28. E. EMMONS.
29. R. P. WHITFIELD.
30, 31. E. EMMONS.

PLATE IV*f*.

Figs. 1–28. E. EMMONS.
29. Copy.
30. E. EMMONS.
31. Copy.
32. E. EMMONS.

PLATE IV*g*.

Figs. 1–4. E. EMMONS.
5–8. R. P. WHITFIELD.
9. E. EMMONS.
10–13. R. P. WHITFIELD.
14–20. E. EMMONS.
21–25. R. P. WHITFIELD.
26. E. EMMONS.
27. R. P. WHITFIELD.
28–35. E. EMMONS.

PLATE IV*h*.

Figs. 1. R. P. WHITFIELD.
2, 3. E. EMMONS.
4, 5. R. P. WHITFIELD.
6–8. E. EMMONS.
9–11. R. P. WHITFIELD.
12–14. E. EMMONS.
15, 16. R. P. WHITFIELD.
17. E. EMMONS.
18. G. B. SIMPSON.
19, 20. E. EMMONS.
21, 22. R. P. WHITFIELD.
23–25. E. EMMONS.
26. R. P. WHITFIELD.
27–33. E. EMMONS.
34, 35. R. P. WHITFIELD.

PLATE IV*i*.

Figs. 1–4. E. EMMONS.
5. R. P. WHITFIELD.
6.
7–9. E. EMMONS.
10.
11–16. E. EMMONS.
17–19. R. P. WHITFIELD.
20. G. B. SIMPSON.
21–23. E. EMMONS.
24–26. R. P. WHITFIELD.
27–30. E. EMMONS.
31–32. R. P. WHITFIELD.
33–35. E. EMMONS.
36. R. P. WHITFIELD.
37. E. EMMONS.

PLATE IV*k*.

Figs. 1. E. EMMONS.
2, 3. Copies.
4–22. E. EMMONS.
23, 24. Copies.

LIST OF SECTIONS OF THE SHELLS OF GENERA AND SPECIES OF BRACHIOPODA PREPARED FOR THE STUDY OF THE MICROSCOPIC STRUCTURE.

The preparation of these sections was begun many years since, and some examples were illustrated in the report of 1883.

The cutting machinery devised and constructed under my direction many years since, has not been in my control for several years past, and therefore comparatively little progress has been made in this work. The list now numbers over 500 sections, and we have material on hand for making a considerable increase in the number here stated. Instead of making this study of microscopic structure a part of the current volume, I have concluded to defer the work till some future time when it may be taken up as a special study.

LIST OF MICROSCOPIC SECTIONS OF BRACHIOPODA.

DECEMBER 1, 1890.

	Number of sections.
Lingula punctata	2
densa	2
Lingulepis pinniformis	2
Orbiculoidea Conradi	1
media	5
Schizotreta conica	8
Crania Hamiltoniæ	1
crenistria	1
Orthis tricenaria	3
Hippolyte	1
pectinella	2
flabellula	6
plicatella	5
Ella	1
subquadrata	4
deflecta	1
loricula	1
strophomenoides	1
sinuata	4
occidentalis	18
insculpta	6
biforata	4
biloba	4
Clytie	9
testudinaria	13
Meeki	4
Orthis elegantula	11
emacerata	3
subæquata	4
perveta	5
borealis	2
subcarinata	3
lenticularis	3
superstes	1
Michelini	13
Vanuxemi	17
circulus	2
Penelope	5
hybrida	12
Livia	4
Missouriensis	1
dubia	1
Tulliensis	7
impressa	2
Iowensis	7
multistriata	3
Billingsella Laurentina	4
Scenidium pyramidale	4
Clitambonites Verneuili	1
Triplecia Ortoni	1
Strophomena sulcata	2
tenuis	2

	Number of sections.
Strophomena planoconvexa	2
planumbona	2
fluctuosa	1
Orthotetes subplana	3
crenistria	3
prava	1
lens	1
umbraculum	2
Hipparionyx proximus	1
Meekella occidentalis	1
Leptæna rhomboidalis	18
Rafinesquina alternata	9
Strophodonta arcuata	4
ampla	4
perplana	14
magnifica	1
crebristriata	5
demissa	14
junia	3
nacrea	3
concava	14
striata	3
Strophonella semifasciata	4
reversa	1
Plectambonites sericea	4
Chonetes deflecta	3
coronata	11
scitula	3
mucronata	9
Productus subalatus	2
Spirifer fimbriatus	1
mucronatus	7
granuliferus	5
zic-zac	1
pennatus	6
cyclopterus	1
macropleura	4
perlamellosus	8
urbana	1
lævis	3
medialis	4
Hungerfordi	3
Spirifer sculptilis	2
Amboccelia umbonata	5
Spiriferina spinosa	1
Cyrtina Hamiltonensis	9
Syringothyris textus	10
Athyris Roissyi	1
congesta	2
spiriferoides	9
Atrypa reticularis	7
aspera	1
spinosa	3
Whitfieldia Maria	6
Meristella nasuta	4
Zygospira modesta	1
erratica	1
Nucleospira pisiformis	2
concinna	6
Trematospira camura	2
nobilis	1
hirsuta	3
Retzia evax	4
Adrieni	2
Rhynchonella capax	2
Sappho	5
Stricklandi	2
Linneyi	2
Leiorhynchus multicosta	2
Eatonia medialis	4
Anastrophia internascens	1
Rhynchotreta cuneata	3
Pentamerus pseudogaleatus	6
Pentamerella arata	1
papilionensis	2
Stricklandinia sp	1
Amphigenia elongata	1
Rensselæria ovalis	2
Leptocœlia imbricata	1
Tropidoleptus carinatus	12
Cryptonella rectirostra	5
Total species, 133; sections	538

I communicate herewith the report of Prof. J. M. Clarke, Assistant Palæontologist, giving special account of the additions to the collection and making some earnest appeals for means for carrying on field-work which has almost entirely ceased for more than ten years, thus leaving the Museum collections far in arrears of the present condition of our knowledge, especially of the older rocks and their contained fossils. Having so often and through many years recommended persistent and systematic field-work, in order to maintain the status and prestige of the Museum, I can only express the hope that some plan of work may be adopted when a moderate share of the Museum appropriation can be devoted to this object.

The Trustees of the Museum are to be congratulated in having secured the valuable collection of Trenton Limestone fossils from Mr. William Rust. The Museum collections have heretofore been quite too barren in the fossils of this period. In the same connection I can not help recalling our futile efforts on two previous occasions to secure collections of fossils of the Trenton Period.

I can not refrain from again calling your attention to the great need of fossils of the Cambrian system, of which we have scarcely anything worth mentioning.

I communicate herewith three papers by Prof. J. M. Clarke, one entitled a note on CORONURA DIURUS, Green (sp.); the second, Observations on TERATASPIS GRANDIS, Hall, the largest known Trilobite; the third, Notes on the GENUS ACIDASPIS.

These papers are interesting and important contributions to our knowledge of two very interesting genera and species of Trilobites, and since the Museum has recently come into possession of a nearly entire example of *Coronura aspectans*, the note on this species is very opportune.

In the same connection I communicate a catalogue of the American Palæozoic Brachiopoda, prepared by my private assistant, Mr. Charles Schuchert, under my direction. This catalogue will be an important adjunct to the volume now in progress on the revision of the genera of the Palæozoic Brachiopoda.

This catalogue is not yet finished and can not be satisfactorily completed till the publication of the volume now in press, and on that account I ask the privilege of communicating the remainder

at some time before this report shall be transmitted to the Legislature.

In conclusion I beg leave to state that of the volume of Palæontology now in press, about 250 pages are now in type. The lithography is completed to within two plates. These plates are now in the hands of the lithographer, and will be completed before the 1st of January, 1891.

The work of preparing the original drawings for the second part of the volume is progressing. We shall however soon be in want of new material, which I propose to obtain with little delay.

I hope to have an opportunity of showing to the committee on the State Museum the lithographed plates, and original drawings already prepared for the second part of volume VIII of the Palæontology of New York.

All of which is respectfully submitted by

Your obedient servant

JAMES HALL,
State Geologist.

December 1, 1890.

REPORT TO THE DIRECTOR

ON THE

Condition of the Palæontological Department

OF THE

NEW YORK STATE MUSEUM,

1890.

REPORT OF ASSISTANT PALÆONTOLOGIST.

ALBANY *November* 6, 1890.

JAMES HALL, LL. D., *Director:*

SIR.—The most notable addition during the past year to the Palæontological Department of the Museum, has been the acquisition of a large collection of fossils from the Black river limestone, Trenton limestone, Utica slate and Hudson river shales and sandstones from the central part of the State; a purchase from Mr. Wm. P. Rust, of Trenton Falls. This collection is especially rich in the beautiful trilobites and crinoids of the Trenton, which are now becoming rare and difficult to obtain; the gastropods and cephalopods of this formation are excellently represented. It also contains a fine series of the Utica slate fossils, with an exceptionally complete representation of the developmental stages of the trilobite *Triarthrus Becki*, fine specimens of *Cyathophycus*, graptolites, etc. As a whole this collection strengthens our series of New York fossils very materially, helping to fill the serious gap in our illustration of the earlier palæozoic faunas of the State. A few specimens only from the collection have been placed in the exhibition cases, replacing some less satisfactory examples of prominent species; it has been necessary to place the greater part of it in the drawers on the south and east tiers of cases on the Palæozoic floor of Geological Hall.

Comparatively little has been added to the collections through work in the field by members of the staff. During the month of August the Assistant Palæontologist made some collections from the Genesee and Lower Portage shales of Ontario and Yates counties, securing eleven boxes of specimens, only a part of which have been opened. Our representation of these faunas has been exceedingly meager, and though probably superior to that of any other institution, has afforded no adequate conception of their variety and composition. The material thus acquired will be helpful in completing this series, and we may expect much more substantial assistance in this direction from the services of Mr.

D. D. Luther, of Naples, N. Y., with whom some negotiations have been made.

With the aid of Mr. Charles Schuchert, the Assistant Palæontologist has also made some collections from the Oriskany sandstone on Becraft's Mountain, near Hudson.

Mr. Jacob Van Deloo has collected from the Potsdam sandstone at the Ausable Chasm, and Chazy limestone at Keeseville.

The Museum is under especial obligations to Sir William Dawson, of Montreal, for the donation of a series of specimens illustrating the remarkable fossil sponges described by him from the Levis formation. In addition to these the same gentleman has generously contributed interesting specimens of brachiopods and other fossils, as seen in the accompanying list.

The need of more extensive and systematic work in the collection of fossils from faunas in our own State is poignantly felt. Of the rich primordial faunas our representation is meager in the extreme. Private individuals and representatives of the U. S. Geological Survey have carried on extensive operations among the early rocks of the State securing materials which it may not be possible to duplicate for years to come. From lack of means the State Museum has been unable to enter into competition with these collectors, or to make any serious effort to secure for itself a series of these most important fossils. The study of these primordial faunas as developed in our own State has in other places awakened the greatest interest and enthusiasm, and we do ourselves and students of geology throughout the State of New York an injustice in not providing, in the State Museum, the means of illustrating them. The time of the Assistant Palæontologist is given almost exclusively to he preparation of the Palæontology of New York. Field-work can not be undertaken by him at present without equivalent neglect of his more immediate duties. There is no other member of the staff who can be called upon for such services without similar neglect in other directions. The needs of this department urgently call for the services of an intelligent and muscular man, who could be kept in the field during the months suitable for such work, and be busied with the more mechanical work of conservator for the remainder of the year. Such a man might be obtained at a moderate salary, and his services be equally useful to the departments of Geology, Mineralogy and Palæontology.

The work of preparing for exhibition the fossil crustacea of the palæozoic rocks has been initiated, and will progress as rapidly as the other duties of the Assistant will permit. No essential changes have been made in the arrangement of the fossils on either the second or third floors of the Geological Hall. The new material coming in to the department is mostly received and stored in drawers at the State Hall.

Respectfully submitted

J. M. CLARKE,
Assistant Palæontologist.

List of Accessions to the Department of Palæontology.

By Purchase.

	Specimens.
From William P. Rust, Trenton Falls, N. Y.:	
Black River limestone, Alder Creek, near Boonville, N. Y. (Museum ticket, 1161)	260
Trenton limestone, Trenton Falls (Museum ticket, 1164)	891
Trenton shale, near Holland Patent (Museum ticket, 1165)	182
Utica slate, Holland Patent (Museum ticket, 1231)	770
Hudson River shales, near Rome (Museum ticket, 1232)	334
Hudson River sandstone, erratic blocks (Museum ticket, 1233)	341
Total	2,785

	Specimens.
From A. L. Arey, Rochester, N. Y.:	
Dalmanites aspectans, Conrad. An entire individual from the Corniferous limestone at Lime Rock, N. Y.	1
From Mr. Tubbs, New York, N. Y.:	
Dalmanites myrmecophorus, Green. A large pygidium figured in Palæontology of New York, vol. vii, pl. xiv, fig. 1	1

By Exchange.

From A. L. Arey, Rochester, N. Y.:	
Phacops trisulcatus, Hall. Clinton group, Rochester	1
Bronteus occasus, Winch. and Marcy. Niagara group, Rochester	1
Lichas, sp. indet. Niagara group, Rochester	1
From F. A. Blair:	
Lot of fossils from the Choteau limestone of Missouri.	
From C. E. Beecher, New Haven, Conn.:	
Tornoceras uniangulare, Conrad. Hamilton group, Wende Station	3
From Emmett Brown, Belfast, N. Y.:	
Fossils from Spergen Hill, Indiana, as follows:	
Rhynchonella Grosvenori	12
Terebratula formosa	6

	Specimens.
Terebratula turgida	6
Athyris trinuclea	6
Eumetria Verneuiliana	6
Rhynchonella mutata	4
Orthis dubia	3
Pentremites conoideus	6
Cypricardella oblonga	7
Nucula Shumardana	8
Leptopsis Levettii	1
Athyris trinucleus	6
Zaphrentis spinulifera	5
Productus Indianensis	6
Productus tenuicostatus	5
Productus biseriatus	3
Bellerophon sublaevis	6
Endothyra Baileyi	40
Leperditia carbonaria	20
Murchisonia vermicula	10
Murchisonia insculpta	6
Murchisonia attenuata	8
Holopea Proutana	6
Cyclonema Leavenworthanum	6
Lamellibranchs (undetermined)	6
Trilobite tail	1

BY COLLECTION.

By J. M. Clarke:

Fossils from the Genesee shales and limestone, and Lower Portage (Naples) shales and sandstones. Ontario and Yates counties. Eleven boxes, one slab.

By J. M. Clarke and Charles Schuchert:

Fossils from the Oriskany sandstone, Becraft's Mountain, approx. 450

By Jacob Van Deloo:

Fossils from the Potsdam sandstone, Ausable Chasm (Museum ticket, 1096) 31

Crustacean (?) tracks from the Potsdam sandstone, Keeseville. Two slabs.

Fossils from the Chazy limestone, Keeseville (Museum ticket, 1113, 1114) 132

BY DONATION.

From Sir William Dawson, Montreal:	Specimens.
Orthisina Verneuili, Eichwald. Anticosti	4
Hindella umbonata, Billings. Anticosti	5
Orthis porcata, Billings. Anticosti	4
Orthis hybrida, Sowerby. Anticosti	2
Atrypa marginalis, Dalman. Anticosti	5
Orthis (?) *Laurentina*, Billings. Anticosti	5
Meristina didyma (?), Dalman. Picton	11
Lingulepis pinniformis, Owen. Beverly	1
Linnarssonia pretiosa, Billings. Little Metis	7
Bolboporites Americanus, Billings. Chazy, Montreal	7
Blastoidocrinus carcharidens, Billings. Montreal	1
Murchisonia Anna, Billings. Calciferous, Montreal	1
Monticulipora. Chazy, Montreal	1
Bythotrephis pergracilis, Dawson. Little Metis	1
Protospongia monema, Dawson. Little Metis	2
P. delicatula, Dawson. Little Metis	1
P. coronata, Dawson. Little Metis	2
P. cyathiformis, Dawson. Little Metis	1
Acanthodictya hispida, Dawson. Little Metis	1
Cyathospongia tetranema, Dawson. Little Metis	2
C. Quebecensis, Dawson. Little Metis	1
Hyalostelia Metissica, Dawson. Little Metis	4
From E. B. Knapp, Skaneateles:	
Dalmanites Boothi, Green (in pyrite nodule). Hamilton group, Livingston county	1
Platystoma cochleatum, Hall. Corniferous limestone, Onondaga Reservation	3
Asaphus megistus, Locke. (Plaster cast, showing under surface and appendages.)	

CONTINUATION

OF

DESCRIPTIONS OF BRYOZOA,

NOT PRINTED IN VOLUME VI,

PALÆONTOLOGY OF NEW YORK,

FOR THE

REPORT OF THE STATE GEOLOGIST,

1890.

DESCRIPTIONS OF BRYOZOA.

Paleschara pertenuis.

Paleschara pertenuis. Hall, Trans. Albany Institute, vol. x, p. 179, 1881.
" " " Report of State Geologist for 1883, p. 7, 1884.
" " " Palæontology of New York, vol. vi, p. 237. Not figured, 1887.

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Zoarium consisting of extremely thin foliaceous expansions incrusting other objects; all the specimens are incrusting cyathophylloid corals; greatest thickness observed, .20 mm. Cells sometimes polygonal, but usually circular or oval, walls thick; diameter .33 mm., either irregularly disposed, or forming intersecting rows. Interstitial cellules minute, rarely a cell is entirely surrounded by them; sometimes there are only one or two for each cell, and at other times for a considerable space the cells are in contact, without intermediate cellules. Surface marked by maculæ or very slightly elevated monticules, the centers of which are distant about 3.50 mm.; a space 1.50 mm. in diameter being occupied by cells larger than the others, and having a diameter of about .50 mm.

This species may be distinguished from others of this formation by the more nearly circular or oval cells, and their crowded or confused appearance.

Formation and locality.— Hamilton group, Darien Centre, Erie county, N. Y.

Paleschara intercella.

Paleschara intercella, Hall. Trans. Albany Institute, vol. x, p. 179, 1881.
" " " Report of State Geologist for 1883, p. 5, 1884.
" " " Palæontology of New York, vol. vi, p. 237. Not figured 1887.

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Zoarium consisting of extremely thin foliaceous expansions incrusting other objects, most frequently cyathoplylloid corals. Cells polygonal, .33 mm. in diameter, in contact, sometimes irregu-

larly disposed; at other times forming intersecting rows, the surface of the frond presenting a somewhat regularly reticulated appearance. Interstitial cells about equal in number to the larger ones, diameter .8 mm. usually quadrangular, square or oblong, the shape and size varying according to the width of the adjacent sides of the large cells. Surface marked by broad, slightly elevated monticules, the centers of which are distant about 3.50 mm.; and have a space about 1.50 mm. in diameter occupied by larger cells of .45 mm. in diameter. The summits of the cell walls have frequently short triangular spinules, usually occurring at the angles, but sometimes on other portions of the walls.

This species closely resembles *P. reticulata*, but the cell walls are thinner, the cells are smaller, and the interstitial cells are much more frequent; from *P. pertenuis* it is distinguished by the thinner cell walls, the more closely disposed maculæ and the more decidedly polygonal form of the cells; from *P. varicella* by the smaller cells, more closely disposed monticules, and the presence of interstitial cells; from *P. amplectens* by the larger size of the cells; from *P. incrustans* of the Lower Helderberg group, by the thinner cell walls, the smaller cells, more numerous interstitial cells, with larger cells on the monticules.

Formation and locality.— Hamilton group, York, Livingston county, N. Y.

Paleschara reticulata.

Paleschara reticulata. Hall, Trans. Albany Institute, vol. x, p. 179, 1881.
" " " Report of State Geologist for 1883, p. 6, 1884.
" " " Palæontology of New York, vol. vi, p. 237. Not figured, 1887.

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Zoarium, consisting of extremely thin foliaceous expansions incrusting other bodies, greatest thickness observed .33 mm. Cells usually pentagonal or hexagonal, sometimes quadrangular, diameter .35 mm., in contact; usually irregularly disposed, but sometimes arranged in undulating intersecting rows, and generally, when so disposed, the cells are quadrangular, giving to the surface a somewhat regularly reticulate appearance. Interstitial cells minute and on some of the fronds very infrequent. Surface marked by maculæ, the centers of which are distant 4 or 5 mm., with a central space 1.50 mm. in diameter, occupied by larger

cells, which have a diameter of .45 or .50 mm. When the surface is well preserved the angles of the cell walls are ornamented with small spinules.

Sometimes there are remains of very fragile projections on the margins of the aperture, which are probably the remains of a lip, which extended partially over the aperture, as in the recent Flustra. This feature if complete would give to the frond a very different appearance from that which it now presents.

This species may be distinguished from *P. intercella* by its somewhat larger cell apertures and more distant monticules; from *P. variacella* by the presence of interstitial cells, and the much less variation in size between the ordinary cells and those on the monticules; from *P. pertenuis* by the more decidedly polygonal cells, and the less crowded or confused appearance of the surface; from *P. amplectens* by the larger cell apertures; from *P. incrustans* of the Lower Helderberg group, by the more frequent interstitial cells and the variation in size between the ordinary cells and those on the monticules.

Formation and locality.— Hamilton group, York, Livingston county, N. Y.

Paleschara variacella.

Paleschara variacella, Hall. Trans. Albany Institute, vol. x, p. 179, 1881.
" " " Report of State Geologist for 1883, p. 7, 1884.
" " " Palæontology of New York, vol. vi, p. 237. Not figured, 1887.

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Zoarium consisting of extremely thin foliaceous expansions incrusting other bodies, most frequently Cyathophylloid corals; greatest thickness observed .50 mm. Cells polygonal, from quadrangular to hexagonal, diameter about .28 mm., sometimes a little longer than wide; in contact; usually irregularly disposed but sometimes in intersecting rows, the frond presenting a somewhat regular reticulated appearance. There are no interstitial cells on the specimens observed. Surface marked by slightly elevated monticules, the centers of which are distant about 4 mm. with a space 1.50 mm. in diameter occupied by larger cells which have a diameter of from .45 to .60 mm. The angles of the cell walls are frequently ornamented by strong spinules.

This species may be distinguished from *P. intercella* by the smaller ordinary cells, larger cells on monticules and the absence of interstitial cells; from *P. reticulata* by the absence of interstitial cells; from *P. pertenuis* by the more decidedly angular cell apertures and the absence of interstitial cells; from *P. amplectens* by the larger cells; from *P. incrustans* of the Lower Helderberg group by the cells on the monticules being larger than the others.

Formation and locality.— Hamilton group, York, Livingston county, N. Y.

Paleschara amplectens.

Paleschara amplectens, Hall. Trans. Albany Institute, vol. x, p. 179, 1881.
" " " Report of State Geologist for 1883, p. 7, 1884.
" " " Palæontology of New York, vol. vi, p. 237. Not figured, 1887.

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Zoarium consisting of extremely thin foliaceous expansions incrusting other fossil bodies, especially crinoid columns; greatest thickness observed less than .25 mm. Cells polygonal, varying from quadrangular to hexagonal, in contact; diameter .20 mm., sometimes irregularly disposed; at other times forming oblique intersecting rows, giving to the surface a regularly reticulated appearance; the margins of the cell walls have frequently minute nodes or spinules at the angles; sometimes they occur on other portions of the margins. The surface is not marked by maculæ or monticules; the cells being of uniform size.

This species may be distinguished from any other of this geological formation by the smaller size of the cells, and the absence of maculæ or monticules.

Formation and locality.— Hamilton group, shore of Seneca lake, N. Y.

Stictopora rectalinea.

Stictopora rectalinea, Hall. Palæontology of New York, vol. vi, p. 245, pl. lxiii, fig. 23, 1887.

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This species in its general appearance most nearly resembles *S. crescens* and *S. rigida* of the Upper Helderberg group; from the former it may be distinguished by the smaller, more distant

cell apertures, the greater number of ranges of cell apertures, the striated convex space between the ranges of apertures, and the smooth noncelluliferous marginal space; from *S. rigida* it may be distinguished by the wider branches, greater number of ranges of apertures, the smaller, more distant and more decidedly oval cell apertures, and the broader, convex space between the ranges of apertures; in that species the ranges of apertures are separated by strong angular, striated ridges, not wider than the cell apertures; from *S. crenulata* it may be distinguished by its wider, more rigid branches, greater number of ranges of oval apertures, and convex interspace; from *S. subrigida* and *S. angularis*, by its wider branches, oval, not pustulose cell apertures, and the absence of strong ridges separating the ranges of apertures; from *S. recta* by the wider frond, greater number of ranges of apertures, and the absence of strong longitudinal, granulose ridges; from *S. incisurata*, by the parallel margins of the frond and ranges of apertures, the smaller apertures and the convex, striated interapertural space; from *S. trilineata* and *S. tumulosa* by the greater number of ranges of smaller apertures and the convex or subangular, finely striated interspaces.

Formation and locality.— Hamilton group, West Williams, Ontario, Canada.

Stictopora tumulosa.

Stictopora tumulosa, Hall. Palæontology of New York, vol. vi, p. 246, pl. lxi, figs. 18–22, 1887.

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This species in its general appearance and mode of branching most nearly resembles *S. trilineata*, but the frond is thinner, more flattened; the apertures are smaller, more decidedly circular, pustuliform, more distant; the striations are fewer and less prominent; from *S. incisurata* it may be distinguished by the parallel margins of the frond, smaller, circular, pustuliform and more distant cell apertures, the finer, more numerous striations; from *S. sinuosa* it may be distinguished by its somewhat wider branches, smaller, circular, more distant cell apertures, finer and generally continuous stria tions. *S. angularis* and *S. recta* have circular, pustuliform cell apertures, but in those species the ranges of apertures are separated by very prominent, strong

ridges; from the other species, at present known, it may be distinguished by minute, circular pustuliform cell apertures.

Formation and locality.— Hamilton group, Moscow, Livingston county, N. Y.

Stictopora striata.

Stictopora striata, Hall. Palæontology of New York, vol. vi, p. 246, pl. lxiii, fig. 22, 1887.

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This species most closely resembles some forms of *S. tumulosa*, but the aperatures are larger, not so decidedly circular, much less pustuliform; the peristomes are stronger, and the striæ are shorter, broader, and much more numerous; from *S. trilineata* it may be distinguished by the more nearly circular, more oblique, less regularly disposed cell apertures, and the short tortuous striæ; from *S. interstriata* by its more nearly circular cell apertures, the stronger peristomes, the absence of spiniform projections from the interior of the cell tube, the fewer, stronger and much more tortuous striations; from *S. sinuosa* by the broader frond, the more frequent cell apertures, more prominent peristomes, the slighter and much more frequent longitudinal striations; from *S. granifera* by the nearly parallel margins of the frond, much fewer striations, and the absence of nodes on the peristomes and striations; from *S. incisurata* by its numerous striations; from any other species at present known from the Lower and Upper Helderberg and Hamilton groups, by the numerous, short, tortuous striations.

Formation and locality.— Hamilton group, Ontario county, N. Y.

Stictopora sinuosa.

Stictopora sinuosa, Hall. Trans. Albany Institute, vol. x, p. 190, 1881.
" " " Report of State Geologist for 1883, p. 42, 1884.
" " " Palæontology of New York, vol. vi, p. 247, pl. lxi, fig. 17, 1887.

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This species may be distinguished from *S. incisurata* by its narrower form, more rigid appearance, and the sinuous interrupted striations or ridges; from *S. trilineata* by the more rigid form, broadly oval oblique cell apertures, and the sinuous, interrupted ridges or striations; from *S. tumulosa* by the broadly

oval, slightly oblique cell apertures, which never have the pustuliform appearance characteristic of that species; from *S. interstriata* it may be distinguished by the more broadly oval, slightly oblique cell apertures, the strong sinuous striations, and the absence of spinulose projections from the interior of the cell aperture; from the other species at present known in the Hamilton and Upper Helderberg groups it may be distinguished by the narrow, somewhat rigid form, and strong, sinuous, interrupted ridges between the apertures.

Formation and locality.— Hamilton group, south of Auburn, shore of Cayuga lake, N. Y.

Stictopora ovata.

Stictopora ovata, Hall. Palæontology of New York, vol. vi, p. 248, pl. lxiii, fig. 24, 1887.

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This species most closely resembles *S. incrassata*, but may be distinguished as follows: The cell apertures are more broadly oval, the larger end of the ovate aperture is toward the base, the peristome is unequally elevated, the posterior portion being the most prominent and oblique, the cell apertures are more distant longitudinally and more closely disposed transversely, and are smaller and more broadly ovate than those of that species; from the other species, at present known, from the Lower and Upper Helderberg and Hamilton groups, it may be distinguished by the large size and great thickness of the frond, the large ovate cell apertures and the sinuous angular striation between the ranges of apertures.

Formation and locality.— Hamilton group, near the foot of Canandaigua lake, N. Y.

Stictopora incrassata.

Stictopora incrassata, Hall. Trans. Albany Institute, vol. x, p. 190, 1881.
" " " Report of State Geologist, for 1883, p. 47, 1884.
" " " Palæontology of New York, vol. vi, p. 249, pl. lxii, figs. 1-6, 1887.

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This species occurs in association with *Semiopora bistigmata*, and in its manner of growth closely resembles that species, but may easily be distinguished by its more robust form and the absence

of strong longitudinal ridges, and interapertural pits; its size and thickness will easily distinguish it from any other species of the Lower and Upper Helderberg and Hamilton groups, at present known, with the exception of *S. ovata*, and it may be distinguished from that species by the more decidedly ovate form of the apertures and in the posterior portion of the aperture being the narrower, the equally elevated peristomes and the wider space between the rows of apertures.

Formation and locality.— Hamilton group, West Williams, Province of Ontario, Canada.

Stictopora limata.

Stictopora limata, Hall. Palæontology of New York, vol. vi, p. 250, pl. lxi, figs. 14-16, 1887.

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This species has a slight resemblance to the ordinary forms of *S. incisurata;* from those forms having broad longitudinal ridges, it may be distinguished by the more slender frond, its more rigid appearance, comparatively more infrequent bifurcations, smaller cell apertures, and their more regular disposition in parallel, longitudinal rows; from *S. subrigida* it may be distinguished by the somewhat wider branches, larger oval cell apertures, which are not pustuliform. The cell apertures of that species have a diameter of about .10 mm.; are circular and pustuliform; very nearly the same features will distinguish it from *S. angularis.* From *S. recta* it may be distinguished by the somewhat wider branches, smaller and more distant cell apertures, fewer ranges of apertures on a branch; much wider longitudinal ridges, and the absence of nodes on the ridges; from *S. bifurcata* by the more distant bifurcations, fewer ranges of apertures on a branch, and much wider longitudinal ridges, and the absence of minute nodes; from *Ptilodictya parallela* by the smaller cell apertures and the much stronger longitudinal ridges; from *Stictopora rigida* and *S. crescens* of the Upper Helderberg group by the much smaller and comparatively more distant cell apertures.

Formation and locality.— Hamilton group, Darien Centre, N. Y.

Stictopora subrigida.

Stictopora subrigida, Hall. Trans. Albany Institute, vol. x, p. 190, 1881.
" " " Report of State Geologist for 1883, p. 43, 1884.
" " " Palæontology of New York, vol. vi, p. 251, pl. lx, fig. 21, 1887.

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This species very closely resembles *S. angularis*, but the bifurcations occur at much greater intervals, the longitudinal ridges are much more prominent, and the cell apertures somewhat smaller; it also very closely resembles *S. limata*, that species having the bifurcations distant and the cell apertures disposed in parallel rows separated by prominent ridges, whose width is greater than that of the apertures, but its cell apertures are oval and are separated by only a little more than the diameter of an aperture; from *S. rigida* of the Upper Helderberg group it is distinguished by its narrower form, smaller, more decidedly circular and more distant cell apertures, and the broad, rounded, separating ridges; in that species it is narrower and when not worn is sharply angular; from *S. crescens*, by its narrower form, smaller, circular cell apertures, and the broader, more prominent longitudinal ridges; from *S. incisurata*, by the narrower form, parallel margins of the branches and broad ridges separating the ranges of apertures.

Formation and localities.—Hamilton group, near Middleburg, Schoharie county, and railroad cutting, two and a half miles east of Alden Station, Erie county, N. Y.

Stictopora crenulata.

Stictopora crenulata, Hall. Report of State Geologist for 1883, p. 44, 1884.
" " Palæontology of New York, vol. vi, p. 252, pl. lx, fig. 22. 1887.

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This species in the comparatively slight, angular striations between the rows of apertures resembles *S. trilineata* and *S. tumulosa;* it may be distinguished from the former by the smaller, circular cell apertures, the unequally elevated peristomes, the fewer rows of apertures on a branch, the smooth non-celluliferous marginal space; from *S. tumulosa* it may be distinguished by the

narrower form of the frond, the apertures not pustuliform and much less conspicuous, the very oblique cell apertures of the marginal rows, and the narrow non-celluliferous marginal space; from *S. subrigida*, *S. angularis*, *S. recta*, *S. bifurcata*, and *S. rigida* and *S. crescens* of the Upper Helderberg group, it may be distinguished by the more numerous and much finer longitudinal striations; from *S. incisurata* it is distinguished by the narrower form of the frond, more nearly parallel margins, smaller and more indistinct cell apertures, finer and more numerous striations.

Formation and locality.— Hamilton group, near Alden, Erie county, N. Y.

Stictopora angularis.

Stictopora angularis, Hall. Palæontology of New York, vol. vi, p. 252, pl. lxi, fig. 23, 1887.

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This species most closely resembles *S. subrigida*, but the frond is more decidedly subangular along the middle, the cell apertures are more pustuliform, the longitudinal ridges are not so prominent, the frond is wider, and the bifurcations are more frequent; from *S. recta* it may be distinguished by its somewhat wider branches, smaller more decidedly circular, and more prominently pustuliform cell apertures, wider longitudinal ridges, and absence of nodes or granules on the ridges; from *S. trilineata*, it is distinguished by its somewhat narrower form, more frequent bifurcations, smaller, pustuliform apertures, and the prominent longitudinal ridges; it resembles *S. tumulosa* in having pustuliform cell apertures, but the apertures are smaller, and the ranges of apertures are separated by prominent ridges; in that species the striations are more numerous, very slender and slightly elevated; from *S. rigida* and *S. crescens* it is distinguished by its smaller, circular, more distant, pustuliform cell apertures; from *S. crenulata* by the prominent ridges.

Formation and locality.— Hamilton group, four miles south of LeRoy, Genesee county, N. Y.

Stictopora recta.

Stictopora recta, Hall. Palæontology of New York, vol. vi, p. 253. Not figured, 1887.

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This species most closely resembles *S. bifurcata*, but may be distinguished by the much less frequent bifurcations, the parallel margins of the branches, the less variation in size between the marginal and ordinary apertures, less prominent and more irregularly disposed granules on the longitudinal ridges; from *S. palmipes* by the different mode of growth, the absence of lateral branches, narrow non-celluliferous marginal space, smaller cell apertures, and less prominent longitudinal ridges; from *S. angularis* it may be distinguished by the somewhat narrower, more regularly convex frond, smaller, more decidedly oval cell apertures, which are not pustuliform, and the narrower, granulose ridges. The cell apertures of *S. angularis* are circular and pustuliform, and the longitudinal ridges are smooth; nearly the same features will distinguish it from *S. subrigida;* from *S. incisurata*, it may be distinguished by its narrower, more rigid frond, smaller and more closely disposed cell apertures, and comparatively more prominent longitudinal, granulose ridges; from *S. trilineata* and *S. tumulosa* by the narrower frond, and prominent, longitudinal ridges; from *Ptilodictya parallela* by the different mode of growth, narrower form, smaller cell apertures and more prominent ridges; from *S. rigida* and *S. crescens* of the Upper Helderberg group it is distinguished by the narrower frond, smaller cell apertures and comparatively more prominent longitudinal ridges.

Formation and locality. Hamilton group, West Hamburg, Erie county, N. Y.

Stictopora bifurcata.

Stictopora bifurcata, Hall. Palæontology of New York, vol. vi, p. 254, pl. lxiii. fig. 17, 1887.

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This species most closely resembles *S. palmipes*, but may be distinguished by the more nearly parallel margins of the frond, the absence of lateral branches, the smaller cell apertures, the somewhat more slender, longitudinal ridges and the less prominent

nodes; it has also a very close resemblance to *S. recta*, but may be distinguished by its less rigid appearance, much more frequent bifurcations, and greater variation in size between the ordinary cell apertures and those of the marginal rows; from *P. tumulosa* and *S. subrigida* it may be distinguished by its more frequent bifurcations, the oval cell apertures and the narrower ridges; from *Ptilodictya parallela* by the narrower frond, more frequent bifurcations, smaller, more elongate-oval cell apertures, more prominent and more closely arranged longitudinal ridges; from *S. incisurata* by its more frequent bifurcations, smaller and generally more elongate-oval cell apertures, and the nodose, comparatively stronger longitudinal ridges; from *S. sinuosa* by the straight continuous ridges; from *S. trilineata* and *S. tumulosa* by the narrower form, more frequent bifurcations and much more prominent longitudinal ridges; from *S. rigida* and *S. crescens* of the Upper Helderberg group it is distinguished by the more frequent bifurcations, smaller cell apertures and comparatively stronger ridges; from *S. fruticosa* and *S. ovatipora* by the much smaller cell apertures.

Formation and locality.— Hamilton group, near Muttonville, Bristol township, Ontario county, N. Y.

Stictopora palmipes.

Stictopora palmipes, Hall. Trans. Albany Institute, vol. x, p. 189, 1881.
" " " Report of State Geologist for 1883, p. 41, 1884.
" " " Palæontology of New York, vol. vi, p. 255, pl. lx, figs. 19, 20, 1887.

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This species resembles *S. bifurcata* in having oval cell apertures, arranged in regular longitudinal rows, separated by prominent, nodose ridges; but it differs from that species in having lateral branches, and in the non-celluliferous margin occupying the entire space between them. *S. recta* and *S. angularis* have prominent longitudinal ridges much elevated above the peristomes, but the branches of those species are regularly bifurcating, are narrow, rigid in appearance, and the margins are essentially parallel. From all other species, at present known from the Lower and Upper Helderberg and Hamilton groups, this one may be dis-

tinguished by the peculiar mode of branching, and in having the non-celluliferous margin bordering the entire frond.

Formation and localities.— Shales of the Hamilton group, West Hamburg, Erie county; Pavilion, Genesee county, and near Canandaigua lake, Ontario county, N. Y.

Stictopora granifera.

Stictopora granifera, Hall. Trans. Albany Institute, vol. x, p. 191, 1881.
" " " Report of State Geologist for 1883, p. 45, 1884.
" " " Palæontology of New York, vol. vi, p. 257, pl. lxi, figs. 1-6, 1887.

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This species may be distinguished from *S. interstriata* by the difference in manner of growth, the branches being much widened before bifurcating, while in that species the margins of the frond are parallel, the peristomes and interapertural striæ are nearly equal in strength and are granulose; the cell apertures are very indistinct, while in *S. interstriata* they are conspicuous; when a frond of this species is weathered so that the granules are nearly or quite obsolete the resemblance to that species is much greater. From *S. divergens* it may be distinguished by the size of the frond, the width of that species being only from 1 to 1.50 mm., the comparatively greater expansion before bifurcating, the larger cell apertures and the somewhat more numerous striations; from *S. sinuosa* it may be distinguished by the great expansion of the branches before bifurcating, the more lax appearance of the frond, the more elongate oval apertures, more numerous and straighter striations, and the granules on the peristomes and striæ.

Formation and localities.— Hamilton group, near Pavilion village, Genesee county, and Muttonville, North Bristol township, Ontario county, N. Y.

Stictopora divergens.

Stictopora divergens, Hall. Palæontology of New York, vol. vi, p. 257, pl. lxiii, figs. 18, 19, 1887.

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This species most closely resembles *S. granifera*, but the fronds are narrower, the margins of the branches are more nearly parallel, and the branches increase but little in width before bifurcating;

the cell apertures are a little smaller, and the nodes on the peristomes and longitudinal striæ are much finer, the striations are fewer in number and a transverse section of the branch is more nearly oval. The appearance of the frond and manner of growth is very similar to that of *S. rhomboidea* of the Upper Helderberg, but the cell apertures are very different; in that species they are much smaller, and the peristomes are very thin and scarcely elevated, the longitudinal striations are continuous, sinuous or zigzag, usually coalescing between the cell apertures and inclosing a rhomboidal vestibular area; from *S. interstriata* this species may be distinguished by the stronger peristomes, absence of spiniform projections from the interior of the cell wall, the much fewer and stronger longitudinal striations, and the granules of the peristomes and striations; from *S. permarginata* by the longitudinal striations, that species having the interapertural space smooth.

Formation and locality.— Hamilton group, Darien Centre, N. Y.

Stictopora permarginata.

Stictopora permarginata, Hall.		Trans. Albany Institute, vol. x, p. 191, 1851.
"	"	" Report of State Geologist for 1883, p. 46, 1884.
"	"	" Palæontology of New York, vol. vi, p. 258, pl. xiii, fig. 16, 1887.

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This species most closely resembles *S. granifera*, but may be distinguished from that species; the frond is narrower and more rigid in appearance, the branches do not widen before bifurcating, the cell apertures are somewhat larger, much more closely disposed, the peristomes are stronger, the striations are stronger and much more infrequent. It very closely resembles *S. divergens*, but may be distinguished by the wider fronds more infrequent bifurcations, the parallel margins, more closely disposed cell apertures and the stronger nodes on the peristomes and striations.

Formation and locality.— Hamilton group, West Hamburg, Erie county, N. Y.

Stictopora interstriata.

Stictopora interstriata, Hall. Trans. Albany Institute, vol. x, p. 191, 1881.
" " " Report of State Geologist for 1883, p. 45, 1884.
" " " Palæontology of New York, vol. vi, p. 259, pl. lxii, figs. 7–12, 1887.

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This species will be easily distinguished from *S. incisurata* by the narrow, somewhat rigid form, with essentially parallel margins, and the numerous interapertural striations; from *S. granifera* it may be distinguished by its narrower, more rigid form, and the essentially parallel margins, *S. granifera* being much expanded before bifurcation; also, by the somewhat more regularly disposed cell apertures, the spinuliform processes from the inner face of the cell walls, the more slender and much more numerous interapertural striations, and the absence of nodes or granules on the striations and peristomes. When that species is worn, so that the granules are obsolete, the similarity of the two species is much greater. From *Intrapora puteolata* of the Upper Helderberg group it is distinguished by the more rigid appearance of the frond, the essentially parallel margins, the larger, more distant cell apertures, and the spinuliform processes from the inner face of the cell walls.

Formation and locality.— Hamilton group, Fall-brook, four miles from Canandaigua lake, Ontario county, N. Y.

Stictopora recubans.

Stictopora recubans, Hall. Palæontology of New York, vol. vi, p. 260, pl. lxiii, figs. 20, 21, 1887.

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The characteristics of the species are the comparatively broad, flat, non-celluliferous marginal space, and the oblique, recumbent marginal apertures, with a great portion of their cell walls exposed above the substance of the frond. This species very closely resembles *S. vermicula* of the Upper Helderberg group, but the non-celluliferous marginal space is wider, the ranges of apertures are fewer in number, there being eleven or twelve ranges on that species, the ranges of apertures are more distant, the apertures are not so distinctly pustuliform, the cell walls of the marginal apertures are more exposed, and the longitudinal ridges are more

distinct, but the manner of growth and general appearance of the two species are very similar. The curved branches, broad non-celluliferous marginal space, the oblique and recumbent marginal cells, will distinguish it from any other species at present known from the Lower and Upper Helderberg and Hamilton groups.

Formation and locality.— Hamilton group, shores of Seneca lake, Seneca county, N. Y.

Stictopora subcarinata.

Stictopora ? subcarinata, Hall. Trans. Albany Institute, vol. x, p. 191, 1881.
" (*s. g. ?*) *dichotoma*, Hall. By error. Report of State Geologist for 1883, p. 48, 1884.
Stictopora subcarinata, Hall. Palæontology of New York, vol. vi, p. 261, pl. lxiii, figs. 1-6, 1887.

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When the fronds are well preserved this species will be easily distinguished from *Acrogenia prolifera* by the entirely different mode of growth; where only fragments occur it closely resembles that species in some of its aspects, but it may be distinguished by the wider non-celluliferous marginal space, the fewer ranges of cell apertures and the absence of striated longitudinal ridges, the greater variation in size between the marginal and central cell apertures, and the obliquity of the marginal apertures to the axis of the branch; when the central ridge is very prominent, and the others are obsolete, it has some resemblance to *Tæniopora exigua*, but generally the difference between the two species is well marked.

Formation and localities.— Hamilton group, two and one-half miles east of Alden Station, Erie county; Bellona, Yates county, and York, Livingston county, N. Y.

Semiopora bistigmata.

Semipora bistigmata, Hall. Trans. Albany Institute, vol. x, p. 193, 1881.
" " " Report of State Geologist for 1883, p. 51, 1884
" " " Palæontology of New York, vol. vi, p, 262, pl. lxii, figs. 27-29, 1887.

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This species is found associated with *Stictopora incrassata*, and its manner of growth is very similar, but it is easily distinguished by its much more slender form, smaller cell apertures, and inter-

apertural pits. In some conditions of weathering it somewhat resembles *Stictipora perarcta* of the Upper Helderberg group, but may be distinguished by its more robust form, larger cell apertures, and interapertural pits; from any other species, at present known, from the Lower and Upper Helderberg and Hamilton groups, it may be distinguished by its slender form, distant bifurcations, parallel margins and interapertural pits.

Formation and locality.— Hamilton group, West Williams, Ontario, Canada.

Prismopora dilatata.

Prismopora dilatata, Hall. Trans. Albany Institute, vol. x, p. 193, 1881.
" " " Report of State Geologist for 1883, p. 50, 1884.
" " " Palæontology of New York, vol. vi, p. 265, pl. lxii, figs. 13, 14, 1887.

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This species is of rare occurrence. It differs from other forms of *Prismopora* at present known in having lateral branches. It may be distinguished from *P. triquetra* and *P. subconcava* of the Upper Helderberg group, by its much wider branches and larger, more irregularly disposed cell apertures; from *P. paucirama* it may be distinguished by the greater concavity of the sides of the branches, more frequent branching, and much larger cell apertures; from *P. sparsipora* by the much larger, circular and crowded cell apertures; from other species at present known it is distinguished by its large size and frequent branching.

Formation and locality.— Hamilton group, near Leonardsville, Madison county, N. Y.

Prismopora lata.

Prismopora lata, Hall. Palæontology of New York, vol. vi, p. 266. Not figured, 1887.

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This species in size approaches most nearly to *P. dilatata*, but it may be distinguished by the much less frequent bifurcations, the much less concave sides; the more distant cell apertures, their trilobate form, and their disposition in oblique ascending rows; from *P. pauciramus* of the Upper Helderberg group, by its broader form, the triangular spaces along the margin destitute of

apertures, and the much more numerous apertures; in that species there are only nine or ten apertures in the space across the branch, while in this species there are from fifteen to twenty; from *P. triquetra* and *P. subconcava*, it is easily distinguished by its much larger branches.

Formation and locality.— Hamilton group, Hill's gulch, four miles south of LeRoy, N. Y.

Ptilodictya parallela.

Ptilodictya parallela, Hall. Palæontology of New York, vol. vi, p. 270, pl. lxi, figs. 7, 8, 1887.

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When the whole frond is preserved this species is characteristic and will be readily distinguished; when occurring only in fragments, it sometimes closely resembles *Acrogenia prolifera*, in some of its aspects, but it may be distinguished by the somewhat larger, less oblique cell apertures, and the more uniform size of the longitudinal ridges; in that species the central ridge is usually much more prominent, frequently having two or three times the width of the others, and they are all often striated. The branches of this species are very gently convex, while in that one they are subangular; but sometimes the resemblance is very close and from small fragments alone it is difficult to distinguish the species. From *Stictopora subcarinata* it is distinguished by the wider frond, the extremely narrow non-celluliferous marginal space, the more uniform size of the apertures, and the prominent ridges separating the ranges of apertures. From other forms of PTILODICTYA it is distinguished by the circular, comparatively distant cell apertures; from *Stictopora trilineata* it is distinguished by the circular cell apertures, wider fronds, more numerous ranges of apertures and the prominent longitudinal ridges; from *Stictopora rectalinea* by the circular apertures and smooth longitudinal ridges; from *S. subrigida*, *S. angularis*, *S. lineata* and *S. recta* it is distinguished by the much wider frond, greater number of ranges of apertures, and narrow, prominent, smooth ridges.

Formation and localities.— Hamilton group, Darien Centre, Genesee county, and near the head of Canandaigua lake, Ontario county, N. Y.

Ptilodictya plumea.

Ptilodictya plumea, Hall. Palæontology of New York, vol. vi, p. 271, pl. lxi, figs. 9–12, 1887.

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This species most nearly resembles *P. retiformis*, but may be distinguished by the more nearly circular, more distant cell apertures, and the convex, granulose, interapertural space; from *P. scutulata* it may be distinguished by the wider frond, the more distant cell apertures, and the convex interapertural space; from *P. falciformis*, Nich., *P. tenuis*, *P. nebulosa* and *P. lirata*, it may be distinguished by the irregular disposition of the cell apertures; in those species the apertures being arranged in longitudinal rows.

Formation and locality.— Hamilton group, Hamburg-on-the-Lake, Erie county, N. Y.

Thamniscus pauciramus.

Thamniscus pauciramus, Hall. Trans. Albany Institute, vol. x, p. 197, 1881.
" " " Report of State Geologist for 1883, p. 60, 1884.
" " " Palæontology of New York, vol. vi, p. 274. Not figured, 1887.

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This species may be distinguished from *Thamniscus variolata* of the Lower Helderberg group, by the much more slender branches, less frequent bifurcations, and much more closely disposed cell apertures; from *T. Cisseis* by the less robust appearance of the frond, the more slender branches and smaller cell apertures; from *T. Nysa* by the more slender branches, less frequent bifurcations, and more closely disposed cell apertures. From *T. multiramus* of the Upper Helderberg group by the more slender branches, comparatively less frequent bifurcations, smaller fronds and their much more delicate appearance; from *T. nanus* by the less frequent bifurcations, the more uniform size of the branches, and the much more closely disposed cell apertures.

Formation and locality.— Hamilton group, Menteth's point, west shore of Canandaigua lake, Ontario county, N. Y.

Hederella conferta.

Ptilionella conferta, Hall. Trans. Albany Institute, vol. x, p. 195, 1881.
" " " Report of State Geologist for 1883, p. 56, 1884.
" " " Palæontology of New York, vol. vi, p. 279. Not figured, 1887.

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This species may be distinguished from *Reptaria penniformis* by the different appearance of the axial tube, the greater diameter of the cell tubes, their more nearly cylindrical form, and the absence of regular annulations; from *Ptilionella nodata* it is easily distinguished by the absence of prominent regular annulations; from *Hederella cirrhosa* it is distinguished by the much larger cell tubes, their comparatively more frequent occurrence, and the more compact appearance of the frond; from *H. canadensis* by the larger more frequent cell tubes and the more compact appearance of the frond. The cell tubes are of nearly the same size as those of *H. filiformis*, but they are of more frequent occurrence and are never nearly parallel with, nor have their margins in contact with the axial tube, but diverging and having their margins in contact with each other, presenting a more compact appearance than that species; from *H. magna* it is distinguished by the much smaller size of the cell tube.

Formation and locality.— Hamilton group, Darien Centre, Genesee county, N. Y.

Ptilopora striata.

Ptilopora striata, Hall. Trans. Albany Institute, vol. x, p. 196, 1881.
" " " Report of State Geologist for 1883, p. 58, 1884.
" " " Palæontology of New York, vol. vi. p. 283, pl. lxvi, figs. 30–33, 1887.

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This species may be distinguished from *P. tenuis* by the stronger midrib and the more frequent lateral branches; in that species the interval between the branches is nearly twice as great as in this species; from *P. nodosa* it may be distinguished by the more frequent branches and the absence of prominent nodes on the celluliferous face of the midrib and branches.

Formation and localities.— Hamilton group, Moscow, Livingston county, and other localities in Central and Western New York, and also at West Williams, Ontario, Canada.

Ptilopora nodosa.

Ptilopora nodosa, Hall. Trans. Albany Institute, vol. x, p. 196, 1881.
" " " Report of State Geologist for 1883, p. 59, 1884.
" " " Palæontology of New York, vol. vi, p. 285, pl. lxvi, fig. 25, 1887.

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This species may be distinguished from *P. striata* by the more slender, non-tapering midrib, more distant lateral branches, and the presence of a line of nodes along the middle of the celluliferous face of the midrib and branches; from *P. infrequens* it may be distinguished by the more frequent lateral branches; in that species the intervals between the branches being equal to three or four times the width of the branches.

Formation and locality.—Hamilton group, railroad cutting, two and one-half miles east of Alden station, Erie county, N. Y.

Notes on the genus Acidaspis.

Note on Coronura aspectans, Conrad.

Observations on Terataspis grandis, Hall.

By J. M. Clarke.

NOTES ON THE GENUS ACIDASPIS.

By J. M. CLARKE.

Communicated to the State Geologist, December, 1890.

The genus ACIDASPIS, as the term is currently accepted, may be regarded as one of the more compact and homogeneous groups of the trilobites. It may be safely said that it is the pre-eminent influence of the great Barrande, the profoundest student and foremost authority on these fossils, that has brought the name into general usage, though until later years the term proposed by Emmrich, ODONTOPLEURA, has found favor with the German writers.

Conformity to the rules governing nomenclature, which are intended to render justice to every investigator, does not uphold this usage. There is an evident disposition abroad, and one most heartily to be indorsed, to ascertain as far as possible from the descriptions by earlier writers, their intentions. The original diagnoses may have been brief, all too brief to satisfy the present requirements of our science, their illustrations insufficient or faulty, but it will not suffice to reject a name upon these grounds alone. "Too imperfectly described to be identified," is a decree which often veils an unbecoming aspiration after immortality unrelieved by an abiding conviction of the necessity and justice of making every effort to establish the results of another's investigations.

Many of the terms which have been proposed for genera of palæozoic fossils and have fallen into desuetude from the general belief that they are synonyms have a certain definite value; with the advance in our knowledge, and with the greatly augmented size of the generic groups with which we have to deal, many of these names must be revived in their original and strictest significance.

The pertinence of these remarks does not make itself so strikingly apparent in the group of trilobites termed ACIDASPIS, as in many other cases that might readily be indicated. We desire, however, to call attention briefly to the value of various terms which have been propounded for members of this group, expressing at the same time our conviction in regard to their respective values.

The name CERATOCEPHALA was proposed by John A. Warder in 1838,* for a fossil from Springfield, Ohio, well described and illustrated by him. The original specimen, which received the name of *Ceratocephala*

* American Journal of Science and Arts, vol. xxxiv, p. 377.

goniata, was a large cephalon of a trilobite with bases of conspicuous spines upon the occipital ring. That the author figured the specimen in an inverted position, and regarded the occipital spines as antennæ, does not in the least affect the value of this very appropriate generic term. Barrande* recognized the priority of Warder's description, and stated that the term would be entitled to adoption by palæontologists were it not that de Candolle had previously made use of the name *Ceratocephalus* for a genus of plants. Though the two words have the same origin, this fact need not at all affect the validity of both, more especially since they have been used in different departments of natural history, where there is not the slightest possibility of their being confounded. Furthermore, it has been stated by Captain Vodges† that de Candolle's name is no longer recognized by botanists, but has been absorbed into the genus *Ranunculus*. If this be the case, it may serve to fortify the later term, though not materially, for it is perhaps more than likely that de Candolle's term will eventually be resuscitated with a restricted value. For us, however, the existence of de Candolle's term does not in the least affect the value of that of Warder, as the two words are different.

Prior to the use of term CERATOCEPHALA no distinctive name had been applied to these crustacea. Dalman‡ and Hisinger§ had mentioned them under the name PARADOXIDES; ACIDASPIS, Murchison, ODONTOPLEURA, Emmrich, POLYERES, Rouault, TRAPELOCERA, SELENOPELTIS, Corda, DICRANURUS, ACANTHOLOMA, Conrad, terms which have been applied to species of the same group, are all of later date. As a generic term in its broader sense, that is, in the meaning with which ACIDASPIS is now applied, CERATOCEPHALA, must take the precedence of all the rest.‖

Conceding the prior right of this early American writer, we have still before us an interesting inquiry as to whether some of the names subsequently proposed have not a positive value as titles of subsidiary groups.

CERATOCEPHALA was founded on the species *C. goniata*, Warder, which, according to the author was found "in the same locality with the Calymene Blumenbachii, bufo? phylactainoides, and other rare

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*Système Silurien, vol. 1, p. 693.

†Proceedings Academy Natural Sciences, Philadelphia, 1877.

‡Arsberät. om ny zool. arbet. och upptäckt. p. 135, 1828.

§Lethæa Svecica, p. 12, 1837.

‖The only writer who has urged the claims of Warder's term is Captain A.W. Vodges, in the paper already cited in the Proceedings of the Philadelphia Academy for 1877. ("Notes on the genera *Acidaspis*, *Odontopleura*, and *Ceratocephala*.") In his recent valuable "Bibliography of Palæozoic Crustacea" (Bulletin No. 63, U. S. Geological Survey) Captain Vodges has, however, retained the name ACIDASPIS.

fossils;" in other words is a Niagara species. The name of this species has suffered the same obscuration as that of its genus, and has never been admitted to recognition. Barrande observed the close similarity of Warder's figure of *C. goniata* to his *Odontopleura* (1846) or *Acidaspis* (1852) *Verneuili*, and has represented on his plate 38 (fig. 3) a cephalon in a similar position to that given by Warder. For the purpose of comparison copies of both are here introduced. It will be observed that the size attained by these closely related animals is very large compared to that usually prevailing among members of "ACIDASPIS." Barrande's species is from a correlative horizon, his etage E_2. Professor Hall has described* a species from the Niagara limestone at Bridgeport near Chicago, *Acidaspis Danai*, with which the *A. Ida*, Winchell and Marcy,† is a synnonym. The figures of this species given by Professor Hall show with sufficient clearness that this form is identical with *Ceratocephala goniata*, Warder.

In 1847 Corda described‡ the genus TRAPELOCERA, the first of five species being *T. rhabdophora*, Corda, which Barrande subsequently showed to be a synonym of his *Acidaspis Verneuili*. Whatever value this term might have had is therefore lost by its being in all respects synonymous with CERATOCEPHALA.

CERATOCEPHALA in its restricted sense has this positive value. It embraces such forms as agree with the type *C. goniata*, in having a large subquadrate cephalon, strong ridges running from the eyes along the outer branch of the facial suture to the anterior extremity of the glabella, and two strong, straight, divergent spines on the axis of the occipital ring. It will include *Acidaspis Verneuili* and *A. tremenda*, Barrande, *A. vesiculosa*, Beyrich, *A. bispinosa*, McCoy (not Emmrich), *A. Barrandii*, Fletcher and Salter; it is of quite restricted range and specific representation.

The name ACIDASPIS, proposed by Murchison in 1839,§ was founded on the species of *A. Brighti*, Murchison, the part described being the intra-sutural portion of a cephalon characterized by the sharp division of the lateral glabellar lobes and the broad occipital ring produced into a single stout median spine. Species of this type of structure

* Geology of Wisconsin, vol. 1, p. 432, 1862. See for illustration Twentieth Report, N. Y. State Cabinet, pl. 21, figs. 8, 9, 1867 and revised edition, 1870.

† Memoirs of the Boston Society of Natural History, vol. 1, p. 106, pl. 2, fig. 13, 1865.

‡ Prodrom einer Monographie der böhmischen Trilobiten, p. 158. This work, published over the names of Ignaz Hawle and A. J. C. Corda, has, since the publication by Barrande of a disclaimer by Hawle of any participation in its composition, been generally accredited to Corda alone.

§ Silurian System, p. 658.

are usually of small size and are widely distributed, having a very considerable vertical range from the lower Silurian into the middle or upper Devonian. They are subject to variation in some features, especially in the number and arrangement of the spines upon the pygidium, and in this respect afford no means of distinction from the members of other divisions of the genus CERATOCEPHALA.

In 1839 Emmrich proposed* the term ODONTOPLEURA, apparently not in ignorance of Murchison's term, but because he considered it insufficiently defined in being based upon a fragmentary specimen. He described and figured *Odontopleura ovata*, Emmrich, which must be taken as typical of his proposed genus. This species was afterwards refigured by him in 1845† under the name *O. bispinosa*. A highly finished figure of this species, was also given by Burmeister in 1843,‡ made, as it is stated, from the original specimen under the direction of the late H. Von Dechen,§ and from these figures it appears that the species is characterized by the great breadth of body, and by the occipital ring being smooth, or with a central tubercle, but without spines.

In 1840 Conrad described the species *Acidaspis tuberculatus*,‖ a well-known form of the Lower Helderberg fauna, his description being based upon the intra-sutural portion of a cephalon. The species is strictly congeneric with *A. Brighti*, Murchison. At the same time he described without figure or specific designation a fossil to which he gave the name ACANTHOLOMA,¶ and it would appear both from his description and from the opinion expressed by Professor Hall in 1859** that the author had under consideration a free cheek of the same species of ACIDASPIS.

In the report for 1841, Conrad proposed†† the name DICRANURUS for a fossil there figured, also from the Lower Helderberg fauna. This form was mentioned in a list given on a preceding page of the same report as *Dicranurus hamatus* and under the name *Acidaspis hamata* it has become known as one of the peculiar species of this fauna. The

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*De Trilobitis, p. 35, plate, fig. 3.

†"Ueber die Trilobiten," (Neues Jahrbuch für Mineralogie, etc).

‡Organization der Trilobiten, pl. 2, fig. 11.

§Burmeister states that this specimen in the Museum of the University of Berlin, was the only one known of the species, and Heidenhain in 1869 makes the same statement (Zeitschrift der deutschen geologischen Gesellschaft, vol. 21. p. 167).

‖Third Annual Report on the Palæontological Department of the Survey, p. 205, fig. 3 of the plate accompanying a few copies of the report for the following year. (See Fifteenth Report N. Y. State Cabinet.)

¶In his report for the following year Conrad used the term *Acantholoma spinosa* in a list of fossils, but without further definition.

**Palæontology of New York, vol. 3, p. 370.

††Page 48, plate, fig. 1.

species is not well known except from its cephalon which is notable for the extraordinary pair of curved spines originating upon the very broad occipital ring, making almost an entire revolution in a spiral outward curve and resembling a pair of grappling irons. Mr. Conrad regarded this fossil as the entire animal, describing it as without thoracic segments but with a tail prolonged into two great spines; hence the generic name, which is thus a misnomer, but can not be impeached on such a ground. But a single additional species of this well characterized group is known, the *Acidaspis monstrosa*, Barrande, from an equivalent horizon, the etage G. Fragments of the thorax known to belong to these species have been figured by both Hall and Barrande and they indicate structure similar to that of the Ceratocephalæ generally, straight pleuræ, prolonged into spines which are abruptly curved backward and greatly produced. Barrande also figures* a very incomplete pygidium which he surmises may belong to *A. monstrosa*, but it has a lichadiform structure and is totally unlike that figured by Professor Hall† in connection with a portion of the thorax of *A. hamata*. The original of the latter drawing is in the collection of the State Museum, but the pygidium, which had become detached and been gummed in place, has again become loosened and lost, a most regrettable circumstance as assiduous search in the Lower Helderberg rocks which has produced many fine specimens of this fossil has failed to discover another of the pygidium. We may, however, confide in the accuracy of the original representation of this part, in which the pygidium appears to have been of small size, semi-circular in outline, with a single projecting spine on each side near the anterior margin. The figures given on the accompanying plates of the American and Bohemian species will serve to indicate the distinctive characters of this group.

In the work of Corda's already cited (1847) the name SELENOPELTIS‡ was proposed, and four species described, *S. Stephani*, *S. Buchi* (*Odontopleura Buchi*, Barrande, 1846), *S. Beyrichi*, and *S. Humboldti*. Barrande demonstrated in 1852§ that all the fossils thus described represented but one species, his *Acidaspis Buchi*. Corda's generic name was well defined and fully illustrated. This species *Acidaspis Buchi* is remarkable in many respects and we have reproduced Barrande's figure of the entire animal which is almost a copy of that

*Vol. 1, Supplement, pl. 15, fig. 3.
†Palæontology of New York, vol. 3, pl. 79, fig. 19.
‡Page 84.
§Page 746.

given by Corda. The median lobe of the glabella is small, the lateral lobes, instead of being more or less distinctly in two pairs, are confluent and exceedingly irregular; the occipital ring is devoid of spines or conspicuous tubercles and the long cheek spines take their origin above the genal angles and on the upper surface of the cheeks. The thoracic segments are very broad, each annulation bearing at its junction with the pleura a very strong node; the pleural ridges are not direct as in other species, but cross the entire width of the pleuræ obliquely from below upward and are there recurved into very long spines. The pygidium is described by both Corda and Barrande as without marginal spines and hence Corda's name. But Barrande has figured one very imperfect specimen retaining a single spine and in the figure, here copied, they were drawn in dotted lines. The cephalon is also without marginal spines. A comparison of these features with those of the other groups already indicated leaves no doubt that the single example of this type of structure stands well apart from its allies.

In the same year that Corda's "Prodrom" appeared (1847) the term POLYERES was used by Rouault* in a list of the palæozoic fossils found in the vicinity of Rennes, Brittany, for a trilobite which Barrande, after a personal inspection of the specimens, pronounced identical with his *Acidaspis Buchi*. Rouault's description of his genus was very brief. The essential character upon which it was based being the long thoracic spines. The single species mentioned, *Polyeres Dufrenoyi*, Rouault, was not figured. It must be admitted that from the original description alone of POLYERES it would be difficult to recognize its value, but the opinion expressed by Barrande fully determines its worth. As it is necessary to choose between the two terms SELENOPELTIS and POLYERES proposed the same year, it seems the wiser course to accept Corda's name, which was not only clearly defined but was also illustrated.†

It appears from the foregoing that many of the generic names which have been proposed for the trilobites known as ACIDASPIS, have a certain permanent value. If we admit these terms in a classification, the subdivision of the entire group of CERATOCEPHALA is found

* Bulletin de la Sociéte géologique de France, 2 ser. vol. 4, p. 320. This paper was read at the session of December, 1846, and its date is thus quoted by both Barrande and Vogdes. The cover of these *feuilles* 20-25 bears the date of April, 1847.

† In spite of the serious indisposition toward Corda's work evinced by Barrande, a feeling which is explained by the circumstances connected with the appearance of this monograph, it becomes increasingly evident that it contains many kernels of good grain, though concealed among much chaff. The chaff has been sufficiently brought to the foreground. It is obligatory upon students of palæontology to lose sight of the personal differences of a passing generation and uphold the truths that this investigator was fortunate enough to elicit.

to be based to an important degree upon the structure of the occipital ring of the cephalon, whether it be smooth (or with a central tubercle), unispined, bispined, etc. The variations of this character, upon which the subdivisions CERATOCEPHALA (*sensu stricto* TRAPELOCERA), ACIDASPIS and ODONTOPLEURA depend, is not one of high morphological value, but it is not infrequently that variation in such minor details as this has proved of the greatest convenience in a subsidiary classification of the trilobites, for example, among the Phacopidæ and the Proetidæ. In the entire group of CERATOCEPHALA there is no more important variation in essential characters than that of the anchylosis of the cheeks with the cephalon in *Acidaspis Verneuili* and its allies, and the confluence of the lateral glabellar lobes in *A. Buchi.*

The usefulness of the subdivision proposed in the following lies primarily in the homogeneity of the groups and secondarily in the fact that it retains in their original value names of long standing.

SCHEME OF CLASSIFICATION.

Genus CERATOCEPHALA, Warder, 1838 :

Glabella with a long central lobe extending from near the anterior margin of the cephalon to the occipital ring; lateral lobes in two pairs, generally quite distinct from the central lobe. The facial sutures originate just within the genal angles, passing over the ocular nodes and cutting the frontal margin where their anterior terminations are separated by the width of the glabella ; rarely obsolete from coalescence. Eyes small. Thoracic segments generally nine, sometimes ten; extremities of the pleuræ produced into spines. Pygidium with two or three annulations. Margins of cephalon and pygidium and surface of the test generally abundantly supplied with spines.

Type, *Ceratocephala goniata,* Warder.

1. Species having the occipital ring

(a) *Smooth or with a central tubercle.*

ODONTOPLEURA, Emmrich. Type, *O. ovata,* Emmrich.

(b) *With a single, large, straight, median spine.*

ACIDASPIS, Murchison. Type, *A. Brighti,* Murchison.

Synonym, *Acantholoma,* Conrad.

(c) *With two straight, divergent spines.*

CERATOCEPHALA, Warder, *sensu stricto.* Type, *C. goniata,* Warder.

Synonym, *Trapelocera,* Corda.

(d) *With two spirally recurved spines of great size.*

DICRANURUS, Conrad. Type, *D. hamatus* (Conrad), Hall.

2. Species with confluent glabellar lobes, oblique thoracic pleuræ and spineless pygidium.

(e) SELENOPELTIS, Corda. Type, *S. Buchi*, Barrande. Synonym, *Polyeres*, Rouault.

To these it is necessary to add another to include an extravagant form known only from its pygidium, but whose relations are nearest to the genus CERATOCEPHALA:

(*f*) ANCYROPYGE, sub-gen. nov. Type, *Acidaspis Romingeri*, Hall. (Palæontology of New York, vol. vii, p. 71, pl. 16 B, figs. 15–18, 1888).

Pygidium with a short, unsegmented, bullate axis, flanked on the lateral margins by two elongate nodes. Border broad and flattened, its margin bearing twelve long curved spines, four on each side and four behind; the lateral members strongly recurved, the posterior being straight and less divergent. From the surface of the posterior border arise two other spines just above and within the fourth of the lateral marginal spines; these rise at an angle of nearly 45° and were probably nearly of the same length as the rest.

The character of this remarkable trilobite will be seen from the accompanying copies of figures from the work above cited.

The felicity of this grouping makes itself apparent upon attempting an arrangement of the species. The more extravagant forms of CERATOCEPHALA are separated under the three divisions SELENOPELTIS, DICRANURUS and ANCYROPYGE and these are represented by but four known species in all. The actual morphological value of the latter is undoubtedly higher and they are better entitled to independence than the remaining groups.

THE AMERICAN SPECIES OF CERATOCEPHALA

In the palæozoic faunas of North America the genus CERATOCEPHALA is not largely represented.

It has been observed that the earliest species described is the *C. goniata*, Warder, 1838, with which, it seems to us, the *Acidaspis Danai*, Hall and *A. Ida*, Winchell and Marcy, are synonymous.

In a supplementary note to Warder's paper in the American Journal of Science, J. G. Anthony described the species *C. ceralepta*. The woodcuts accompanying this description represent two inverted pygidia of small size, the long marginal spines being regarded as antennæ. Mr. Meek subsequently identified, with some doubt, this species from the Hudson river group at Cincinnati, Ohio,* the original

*Palæontology of Ohio, Vol. I, p. 169, pl. 14, figs. 8, 9, 1873.

locality of Anthony's fossils, and gave figures of two pygidia which, for us, seem to establish the validity of Anthony's designation. At the same time Meek gave figures of two glabellas (*loc. cit.*, figs. 6, 7) without proposing therefor any specific name. Both are characterized by long single occipital spine, that of figure 6 very broad and stout, that of figure 7 much more slender. It appears that a cephalon having the structure of the former of these was subsequently described by S. A. Miller as *Acidaspis anchoralis** and with this cephalon Mr. Miller associated a pygidium having the same structure as that of *Ceratocephala ceralapta* as given by Anthony and Meek. From Miller's description it does not appear how forcible the reason may have been for including these separate parts under the same specific name, but should subsequent investigations prove that these parts referred to *Acidaspis anchoralis* do belong to the same species it would seem that Mr. Miller's name must take its place as synonymous for *C. ceralepta*, for Anthony's figures, though not all that could be desired, show a very characteristic feature in the single pair of long pygidial spines, which do not occur in any other of the known species of this fauna.

In 1842 Dr. John Locke described† the species *Ceraurus crossotus* from the same horizon at Cincinnati. Mr. Meek in the work cited (p. 165, pl. 14, figs. 10 a, b) made an identification of doubtful value (so regarded by him) of this form as a species of ACIDASPIS. It is questionable whether this should be accepted as the species intended by Locke and we prefer to refer to it provisionally as *Ceratocephala crosota*, Meek.

In 1847 Professor Hall described‡ *Acidaspis Trentonensis* and *A. spiniger*. The latter has proved to be a *Bathyurus*.

In 1885 Shumard described§ *Acidaspis Halli*, from the Trenton horizon of Missouri.

In 1857 Billings described‖ *Acidaspis Horani* from the Trenton limestone, Rivière à la Friponne, near Cape Tourment. The original specimen is described as broken at the occipital ring so that its position in this classification is uncertain.

In 1873 Mr. Meek described¶ in addition to the species already mentioned, *Acidaspis Cincinnatiensis*, from the Hudson River group, the original being a pygidium with two thoracic segments attached.

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*Cincinnati Quarterly Journal of Science, vol. 2, p. 349, figs. 2-4, 1875.

†American Journal of Science, 1st Ser., vol. 44, p. 347, fig.

‡Palæontology of New York, vol. I, p. 240, pl. 64, fig. 4, a-f; p. 241, pl. 64, fig. 5.

§First and Second Report Geological Survey of Missouri, pt. 2, p. 200, pl. B, figs. 7, a-c.

‖Report to Sir W. E. Logan for 1856, p. 341.

¶Palæontology of Ohio, vol. I, p. 167, pl. 14, fig. 3.

In 1875, S. A. Miller described from the Hudson River group, *Acidaspis anchoralis*, to which reference has been made, and *A. O'Nealli*.*

In 1876, Professor Hall referred to *Acidaspis* n. sp.? forms subsequently described as *Ceratolichas gryps*, Hall, † and *C. dracon*, Hall,‡ from the Corniferous limestone of New York. At the same time he referred the species *Terataspis grandis*, Hall, and *Lichas Eriopis*, Hall, to ACIDASPIS and indicated a pygidium of *L. Eriopis* as *Acidaspis* (*Terataspis*) sp.? §

In 1879, Mr. C. D. Walcott described,‖ without illustration, *Acidaspis parvula* from the Trenton limestone of Trenton Falls, N. Y.

In 1879, Professor Hall described ¶ *Acidaspis fimbriata* from the Niagara group at Waldron, Indiana. The original specimen was a free cheek of which a figure was first given in 1883.**

In 1887, Mr. A. F. Foerste described†† the species *Acidaspis Ortoni* from the Clinton shales near new Carlisle, Ohio.

In the Palæontology of New York, Vol. VII, 1888, *Acidaspis callicera* was described,‡‡ a species occurring in the Schoharie grit and Corniferous limestone of New York and Canada. A large pygidium was also referred to this genus but without specific name,||| (Corniferous limestone, Cayuga, Ontario). Under the name *Acidaspis Romingeri*, was described¶¶ the form which we have taken as a type of new subgenus, ANCYROPYGE, from the Hamilton fauna of Little Traverse Bay, Michigan.

These North American species arrange themselves under the proposed grouping as follows:

Genus CERATOCEPHALA, Warder, 1838.

CERATOCEPHALA, Warder, *sensu stricto.*

C. goniata, Warder, 1838.

Synonyms *Acidaspis Danai*, Hall, 1862.

A. Ida, Winchell and Marcy, 1865.

ACIDASPIS, Murchison, 1839.

A. anchoralis, Miller, 1875.

=?? A. ceralepta, Anthony (sp.), 1838.

A. tuberculatus, Conrad, 1840.

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* Cincinnati Quarterly Journal of Science, vol. 2, p. 86, fig. 9.

† Illustrations of Devonian Fossils, pl. 19, fig. 1.

‡ Idem, figs. 2, 3.

§ Idem, figs. 4-11, 12.

‖ Thirty-first Report N. Y. State Museum (1879), advance sheets, p. 16.

¶ Description of New Species from the Niagara group, p. 20.

** Eleventh Report State Geologist of Indiana, pl. 33, fig. 11.

†† Bulletin Scientific Laboratories Denison University, vol. 2, p. 90, pl. 8, fig. 1.

‡‡ P. 69, pl. 16 B, figs 1-13.

||| Pl. 16 B, fig. 14.

¶¶ P. 71, pl. 16 B, figs. 15-18.

ODONTOPLEURA, Emmrich, 1839.

O. Trentonensis, Hall (sp.), 1847.
O. parvula, Walcott (sp.), 1877.
O. Halli, Shumard (sp.), 1855.
O. crossota (Locke?), Meek (sp.), 1873.
O. O'Nealli, Miller (sp.), 1875.
O. Ortoni, Foerste (sp.), 1887.
O. callicera, Hall (sp.), 1888.

DICRANURUS, Conrad, 1841.

D. hamatus, Conrad, 1841.

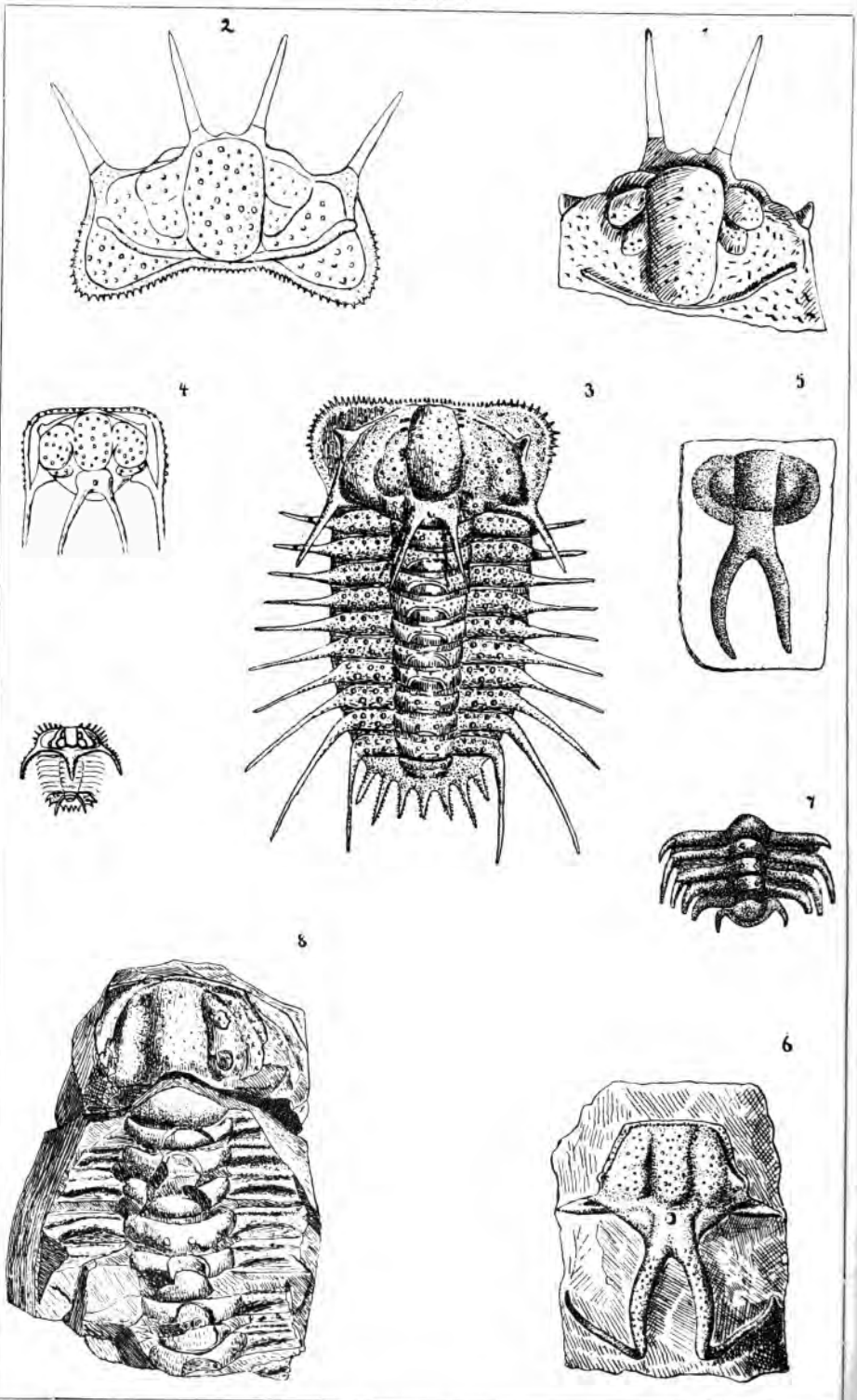
ANCYROPYGE, Clarke, 1891.

A. Romingeri, Hall (sp.), 1888.

Species unclassified:

? Ceratocephala ceralepta, Anthony, 1873.
C. Cincinnatiensis, Meek (sp.), 1873.
C. Horani, Billings (sp.), 1857.
C. fimbriata, Hall (sp.), 1879.

Plate I.



CERATOCEPHALA.

EXPLANATION OF PLATE I.

CERATOCEPHALA GONIATA, *Warder.*

Fig. 1. Copy of the original figure. From American Journal of Science and Arts, vol. xxxiv, No. 2, p. 378.

ACIDASPIS VERNEUILI, *Barrande.*

Fig. 2. Outline copy of a cephalon viewed from in front as in the preceding figure. Barrande, Systême Silurien du Centre de la Bohême, vol. I, pl. 38, fig. 3.

Fig. 3. The entire individual. Barrande, *loc. cit.*, fig. 5.

TRAPELOCERA HOERNESI, *Corda.*

Fig. 4. Copy of the original figure. Corda, Prodrome Einer Monographie der böhmischen Trilobiten, pl. vii, fig. 79a.

DICRANURUS HAMATUS, *Conrad.*

Fig. 5. Copy of the original figure given on the reproduction of the original plate (Fifteenth Rept. N. Y. State Museum), designed to accompany Mr. Conrad's report for 1841.

Fig. 6. A figure from a cephalon retaining all the parts except the free cheeks. From the trilobitic layers of the Delthyris Shaly limestone at Slingerland's, near Clarksville, N. Y.

Fig. 7. The pygidium and a portion of the thorax as given in Palæontology of New York, vol. iii, pl. 79, fig. 19.

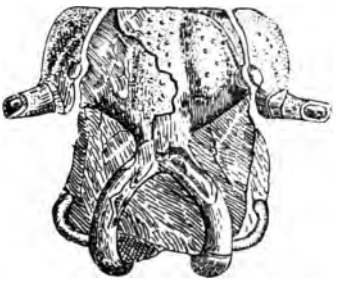
ACIDASPIS MONSTROSA, *Barrande.*

Fig. 8. A specimen showing a portion of the thorax. From Barrande *op. cit.*, Suppl. pl. 15, fig. 1.

ACIDASPIS BRIGHTI, *Murchison.*

Fig. 9. Copy of the original figure in Murchison's Siluria, p. 261, fig. 8.

1



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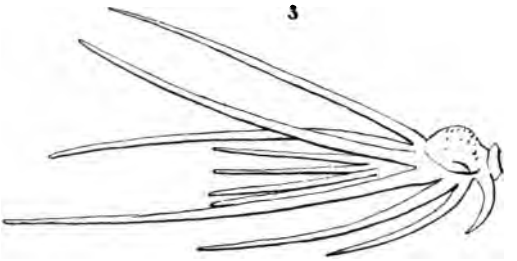

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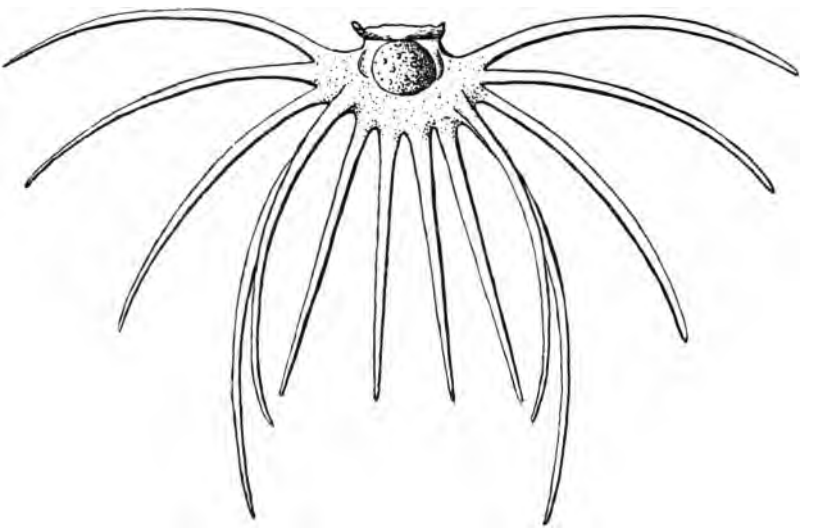

CERATOCEPHALA.

EXPLANATION OF PLATE II.

ACIDASPIS MONSTROSA, *Barrande.*

Figs. 1, 2. Front and profile of a cephalon retaining the detachable cheeks. From Barrande, *op. cit.*, Supplement, pl. 11, figs. 19, 20.

ACIDASPIS ROMINGERI, *Hall.*

Figs. 3, 4. Outline figures of the original specimen, copied from Palæontology of New York, vol. vii, pl. 16*b*, figs. 15, 16.

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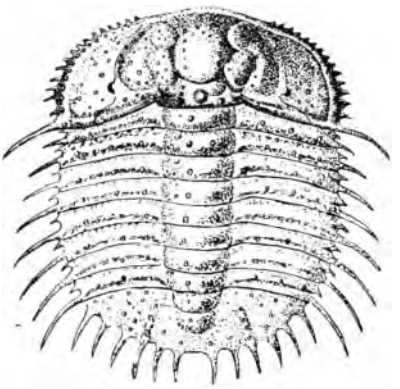

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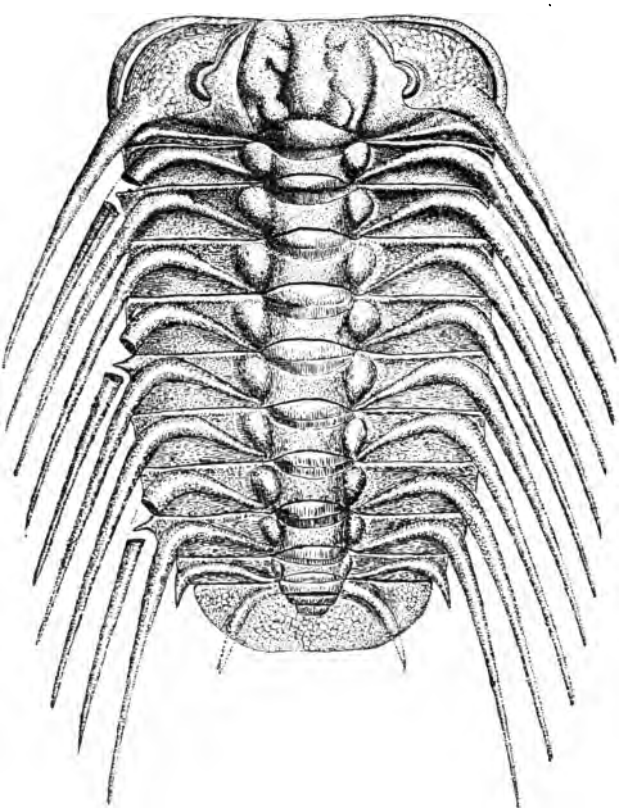


CERATOCEPHALA.

EXPLANATION OF PLATE III.

ODONTOPLEURA OVATA, *Emmrich.*

Fig. 1. Copy of the figure given by Burmeister, Organization der Trilobiten, pl. 2, fig. 11.

ACIDASPIS BUCHI, *Barrande.*

(SELENOPELTIS STEPHANI, *Corda.*)

Fig. 2. An entire individual; after Barrande, *op. cit.*, pl. 37, fig. 25.

NOTE ON CORONURA ASPECTANS, CONRAD (sp.), The Asaphus diurus, Green.

By J. M. CLARKE.

Communicated to the State Geologist December, 1890.

The species *Asaphus aspectans* was founded by CONRAD in 1841* upon a fragment of a cephalon consisting of a free cheek, retaining the lensar surface of the ocular node. This specimen was from the Corniferous limestone at Schoharie, N. Y., and was characterized by the great elevation of the eye (represented by CONRAD as almost semicylindrical), the broad and entire marginal border and the coarse tuberculation of the surface. Until the publication of Volume VII of the Palæontology of New York (1888) the name had not been regarded of much value, from the very fact of the obscurity and apparent insufficiency of the original specimen. Professor HALL had reproduced in the Fifteenth Annual Report on the State Cabinet of Natural History (p. 88, 1862) CONRAD'S brief diagnosis and his figure, and in a short note of observations refers to a second specimen, curiously enough almost the duplicate of the original; both of these specimens, left free cheeks, are figured on plate 13 of the volume of the Palæontology of New York referred to.

In the study of the Upper Helderberg trilobites made in the preparation of this work it became evident that the large pygidia, not infrequent at some outcrops of the Corniferous limestone, characterized by rows of conspicuous marginal spines and a crescentic posterior extremity, and which were currently referred to the species described by Professor HALL as *Dalmania Helena*, or that by Mr MEEK as *Dalmania Ohioensis*, had possessed a cephalon, the eye and cheek of which must have closely conformed to that described as *Asaphus aspectans*. The evidence, however, that these different parts represented but a single species was rather slender, notwithstanding the fact that so much confidence was there felt of this probability that all these pygidia were referred to CONRAD'S species. The argument was on this wise: Professor HALL'S *D. Helena* was based upon a poorly preserved pygidium from the Falls of the

* Fifth Annual Report on the Palæontology of the State of New York, p. 49, plate, fig. 9.

Ohio (see *op. cit.* plate 13, fig. 7), from which all the marginal and terminal spines were lost and the pustulous surface worn away. The original of Mr. MEEK's *D. Ohioensis*, from the Corniferous limestone at Marblehead, Ohio, was a pygidium, the surface of which was also worn smooth, but retained the marginal spines. An abundance of these pygidia from Ohio and various localities in New York (especially from the Lime Rock quarries near Le Roy) rendered their specific identity beyond question. In some material from Ohio which had been loaned by Dr. NEWBERRY was a single fragment, comprising nearly one-half of a cephalon, from the Corniferous limestone at Columbus. This retained one very large and greatly elevated eye, and showed agreement with the original of *Asaphus aspectans* in all the features known. There was no other known trilobite in these rocks to which this cephalon could be referred with any confidence of accuracy, and hence it was presumed that this was the cephalon belonging to the pygidia passing under the names of *D. Helena* and *D. Ohioensis*. Its identity with *Asaphus aspectans* was beyond contravention.

Quite recently the State Museum has obtained possession of an entire individual of this species, which has an interesting bearing on the validity of this identification. This fine specimen was secured in the fall of this year by Mr. ALBERT L. AREY, of Rochester, N. Y., at the quarries at Lime Rock. It consists of two portions, the intaglio retaining the crust, and none of the important parts are missing. All details of structure are well retained, the thinness of the crust showing even the finer tuberculations of the surface. This animal, judging from the dimensions of the pygidium, appears to be of about average size, having a length to the extremity of the horns of the posterior crescent of $5\frac{3}{8}$ inches. To this must be added a fraction due to the slight compression of the posterior portion of the thorax, and the original length of the animal was undoubtedly fully $5\frac{7}{8}$ inches. The character of the cephalon confirms in every respect the identification made in Volume VII. The marginal border is very broad, narrowing into short cheek-spines, and the entire surface of border, cheeks and glabella is coarsely tubercled, The margin itself is regular and uninterrupted, as in *Dalmanites Calypso*, HALL, of the same fauna, and in *D. micrurus*, GREEN, of the Lower Helderberg; not crenulated as in the Lower Helderberg. *D. pleuroptyx*, GREEN, the Schoharie grit species, *D. anchiops*, GREEN, nor spined for its entire extent, as in *D. dentatus*, BARRETT, of the Lower Helderberg, nor baculiferous, as in *D. regalis*, HALL, of the Schoharie grit and *D. pygmæus*, HALL, of the Corniferous, nor dentate on its

anterior arc as in ODONTOCEPHALUS. The eye-lobes are high, the eyes themselves large and elevated. The anterior lobe of the glabella is low, somewhat pentagonal in outline and its definition from the anterior border unusually indistinct. As in most of the DALMANITES of this fauna the lateral members of the first and second pair of lobes are coalesced not only with each other but to a very considerable degree with the eye-lobes. The lateral extensions of the facial suture lie in deep grooves in their passage over the cheeks. The thorax presents no additional features of importance, except that the segments are considerably produced at their lateral extremities, and terminate in sharp points, without showing well-defined articulating faces.

In this specimen, however, the marginal spines of the pygidium are remarkably short, while usually in the New York specimens they are larger than in those from the Corniferous limestone of Ohio. The terminal spines, also, are relatively quite broad and stout and bear on their outer margins three spinules. As far as can be ascertained there is no evidence of erect spines on the crescentic border as in the allied species *Coronura myrmecophorus*, GREEN, but the structure of the posterior crescent shows how closely this form approximates the latter species.

The structure of Mr. CONRAD'S species, *Asaphus aspectans* (which is now to be referred to the genus *Coronura*, proposed in Volume VII of the Palæontology of New York), is established, and it has probably never before happened in the history of discussions upon the trilobites that a species at once so imposing in its proportions and so characteristic of its fauna, has been virtually reconstructed from so insignificant a fragrant, with a meager and imperfect description of that.

We believe, however, that CONRAD'S term must yield to an earlier one of Dr. GREEN'S, *Asaphus diurus*, a name which has never been accepted, from certain imperfections in the original description. This species was proposed in the American Journal of Science and Arts, 1839 (vol. xxxvii, No. 1, p. 40, July), under the title "Description of a New Trilobite." In order to apprehend its value, the essential portion of the description is reproduced:

"Clypeo? costis striatis, tuberculatio; cauda bipartita; corpore depresso.

"The fragments of this Asaph which I have examined, consist of nineteen articulations of the abdomen and tail. *The costal arches of the lateral lobes are very peculiar. They are marked by a shallow groove, or impressed line on their upper surface, studded on each side with quite a*

regular row of bead-like granulations. On each division of the vertebral column, there is but a single row of pustulations. The lunate caudal end is more expanded than in the cognate species, the A. Selenurus, and the concave side of the crescent is more regularly rounded; the whole animal is much more depressed than that species, and the lateral lobes are much wider in proportion to the middle lobe of the back.

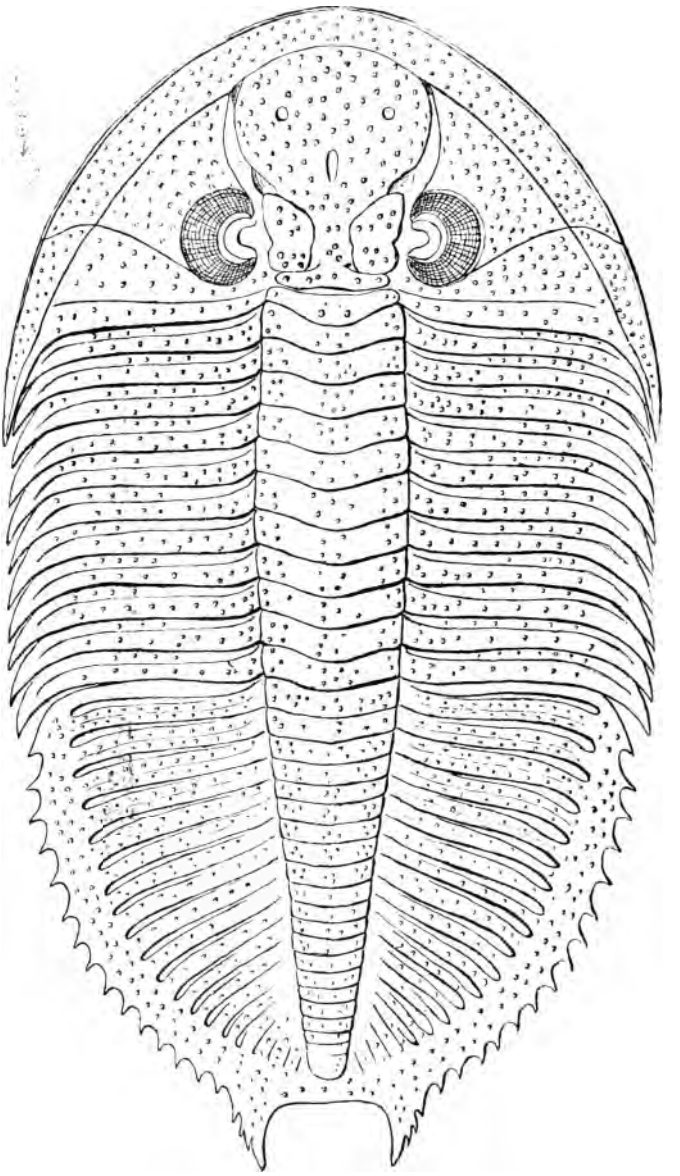
"There are two specimens of this fine species in the cabinet of William Wagner, Esq., of Philadelphia, both of which were found in Green county, Ohio, in the neighborhood of Xenia. The largest which measures two inches long and two and a half inches wide, is a plaster cast from a weather-beaten natural mould; the other occurs in a grey, sparry argillaceous limestone rock. It is perhaps worthy of remark, that all the specimens of the Asaph with a lunate tail, which I have noticed, were natural moulds, made by the animal in the rock, the shell or body having disappeared."

This description was unaccompanied by any illustrations; that portion, however, that we have underlined is a cogent delineation of the characters of the pygidium of *Dalmanites aspectans*. The fossil is hardly to be mistaken. There are but three species of crescent-tailed trilobites, of the size here indicated, that are now known; *Asaphus* or *Odontocephalus selenurus*, *Asaphus* or *Dalmanites myrmecophorus* and *Asaphus* or *Dalmanites aspectans*. Of these Dr. GREEN had himself described two, though the first is usually referred to EATON, who published it in the same year. They are all members of the same (Corniferous) fauna. In MILLER'S Catalogue of the American Palæozoic Fossils, the species is referred to the age of the Niagara; Captain VOGDES in his Bibliography considers it of the age of the Hudson river group, but in neither these nor any other American palæozoic fauna, except the Corniferous, is there any trilobite which even remotely suggests the above description.

The nineteen articulations of the axis of the pygidium, which perhaps from its unusual size the author considered as "abdomen and tail," the grooving of each pleura by a fine impressed line, on each side of which is a regular row of granules, the form of the posterior crescent and the relative proportions of the axis and lateral lobes are all apparent in the figures given in the Palæontology of New York, Vol. VII, and in that accompanying this paper. In the hope of finding Dr. GREEN'S original specimens, search has been made in the collections of the Wagner Free Institute of Science, at Philadelphia, by the favor of its secretary, Mr. CHARLES W. JOHNSON, but the specimens, if extant, are for the time being lost sight of.

Dr. GREEN evidently made an erroneous citation of the locality of these fossils. The Corniferous limestone does not occur near Xenia, and is not known in Green county, Ohio; but an error of this kind is not altogether surprising. No one's knowledge of the geology of Ohio had then attained this degree of discrimination; of the origin of the specimens the author had no personal knowledge; they had come to him through the hands of a collector, upon the accuracy of whose information it is not necessary, in a critical question, to put full reliance.

Plate IV.



CORONURA DIURUS, GREEN.

EXPLANATION OF PLATE IV.

CORONURA DIURUS, *Green* (*sp.*)

Outline drawing of the only entire individual known.

ERVATIONS ON THE TERATASPIS GRANDIS, Hall, The Largest Known Trilobite.

By J. M. CLARKE.

Communicated to the State Geologist December, 1890.

lobites of great size have been reported from various forma-

With rare exceptions, however, these relics are but fragments e test, leaving to the imagination the restoration of the original rtions of the animal, and without an earnest mental effort one to leave the contemplation of the large fragment with no ade- conception of the imposing lineaments of its owner. Indica- of these gigantic forms occur in all the grand faunas of the ɔzoic, with the exception of the Carboniferous where diminution mbers was accompanied by diminution in size, or, in other words, e prevalence of genera in which great size was never attained.

nost with the earliest known appearance of the Trilobites the ɜ PARADOXIDES attained magnificent proportions. *Paradoxides ni*, the well-known species of the Braintree argillites, must have n to a length of 18 inches. ANGELIN has figured an entire speci- ɔf *P. Tessini* 12 inches in length, and BARRANDE a fragment of an idual of *P. imperialis* which must have had about the same size. t. F. MATTHEW has described a nearly entire individual of an nse *P. regina* from the St. John beds, 15 inches long and 12 s across the base of the cephalon, and it is claimed, with ubted accuracy, that this is the largest undismembered specimen rilobite found in any country.

the second faunas great Asaphids were not uncommon. As as 1839 Dr. JOHN LOCKE described in the report of the Geological ɣ of Ohio, a portion of an immense pygidium to which he gave ame *Isotelus maximus*. In 1843 Dr. LOCKE figured an entire indi- l of what he considered the same species, changing the name, ver, to *Isotelus megistus*. This specimen measured nine and three- ers inches in length. The figure was accompanied by outlines o large pygidia, the greater of which was that referred to in 1839, ı, the author says, coincided " with the end of an ellipse 22 inches and 12 inches broad." This is an evidently much compressed ıent, measuring seven inches in its greatest transverse diameter, assuming this as the greatest diameter of the pygidium and

restoring the length from the proportions of the animal as there given, the original length of its owner would have been about 13 inches. The plate is incomplete on its anterior portion, and it is probable that the error in this estimate due to the exaggeration of size from compression of the shield, is compensated by the loss of diameter from imperfect retention. This great pygidium, with other large fragments of the same species, were used as a basis for a well-known restoration in plaster to be found in some of the older museums of this country. ANGELIN has given a restoration of *Megalaspis heros* 14 inches in length and BRÖGGER estimated the original length of *Megalaspis acuticauda* to be fully 16 inches. BARRANDE figured an entire *Asaphus nobilis* from Etage D which measures 10½ inches.

Not until the introduction of the genera DALMANITES, HOMALONOTUS and LICHAS do we meet with the most gigantic proportions attained by these crustaceans, and then only after these genera have become well established. Perhaps none of their representatives in the lower Silurian faunas were of commanding size; in the upper Silurian large but not extravagant proportions were sometimes attained. *Lichas Bolloni* of the Niagara fauna, is a magnificent species, one of the largest of its race and remarkable for the frequency with which its parts are found together, an extremely uncommon occurrence in this thin-shelled group. The *Lichas pustulosus* of the Lower Helderberg shaly limestone was a great species attaining a length of 10 inches or more. *Homalonotus delphinocephalus* of the Niagara fauna grew to large size but does not appear to have attained the length of its successor in the Lower Helderberg, *H. Vanuxemi*, which, according to the restoration from a very large fragment given in the Palæontology of New York, Volume VII (plate V B) grew to a length of at least 11½ inches. SALTER has mentioned (Palæontographical Society, vol. xvii, p. 109) a large fragment of *Homalonatus rudis* which he estimates may have been a foot in length. In later faunas are found traces of this genus of still greater size. Dr. BEUSHAUSEN has figured a pygidium of *H. gigas* from the Spiriferen-sandstein of the Hartz, the possessor of which must have been upward of one foot in length. Unquestionably the largest individual of HOMALONOTUS known is that of *H. major*, from the Oriskany sandstone, figured in the Palæontology of New York, Volume VII (plate V A), a large fragment representing the greater part of the thorax and the pygidium, and according to the restoration there given the original length of the animal must have been well nigh 15 inches. The later and common Hamilton species, *H. DeKayi*, attained no extravagant size though frequently large, e. g. the enrolled individual figured on plate IV (*op. cit.*), the largest entire

specimen reported, which is about 9 inches in length; some large fragments indicate that the animal was sometimes as long as 11 inches.

The size attained by some of the Devonian species of DALMANITES and their immediate predecessors was marvelous. The pygidium of *D. micrurus* figured in the Palæontology of New York, Volume III, page 359 (there given as *D. pleuroptyx*), indicates an individual at least 11 inches in length, and there is reason to believe that the Lower Helderberg species, *D. nasutus* and *D. tridens*, attained a size fully as great. Most remarkable however is the great pygidium of *D. myrmecophorus* of the Corniferous limestone, figured upon plate XV of Volume VII (*op. cit.*), which from the restoration there given, made from careful comparative measurements, would imply an individual 16 inches long.

An interesting feature of the early Devonian trilobitic faunas is the reappearance of CALYMENE in the Schoharie grit and Corniferous limestone, a fact which has been duplicated by the recent description by Dr. OEHLERT of a large species (*C. reperta*), from the lower Devonian of Saint Malo in Angers. The American Devonian species, *C. platys*, is not only the latest but the largest known representative of the genus, and for a group which at its maximum development in species and individuals in the Silurian, rarely attained considerable dimensions, the proportions reached by *C. platys* are especially noteworthy. The entire individuals on plate 1 of Volume VII of the Palæontology show this, and the restoration accompanying a very large pygidium on plate XXV, if accurately drawn, indicates that a length of upward of eight inches was sometimes attained by the species.

No larger or more extravagantly ornamented trilobite than the *Terataspis grandis*, Hall, is known. This giant of its race has left fragments of its test in the Schoharie grit of eastern New York, and in the commingled Schoharie and Corniferous faunas of the Province of Ontario. A very complete illustration and discussion of its different parts, are given in Volume VII of the Palæontology (p. 73, pls. XVII, XVIII, XIX), and from these one readily obtains an idea of the structure of the cephalon, thorax and abdomen, the free cheeks alone being there unrepresented. There is, however, a very large free cheek in a fragment of Schoharie grit in the collection of the American Museum of Natural History, which in all probability belongs to this species. At the time of the preparation of this volume of the Palæontology of New York, the original specimen of Mr BILLINGS' species *Lichas superbus*, was made accessible for study by the kindness of the Director

of the Geological and Natural History Survey of Canada. specimen is a portion of the cephalon and a pygidium of *Ter grandis*, lying in juxtaposition on the same block, there bei doubt of their having belonged to the same animal. From this men it was possible to establish the relative proportions of cep and pygidium in this species, and from the data furnished by s material under study, with careful comparative measurements of specimens of LICHAS in the collections of the State Museum, a figures of such specimens as have been given by ANGELIN, BAR and SCHMIDT, the accompanying reproduction of the original s the animal has been drawn, its base being the largest and most plete cephalon figured in the work cited (pl. xvii, fig. 1; xviii, figs.

This restoration gives to the proprietor of this cephalon a leng nearly 20 inches. The figure does not however do full justi the proportions of the animal. In the cephalon which has s as a base for the restoration the great ovoid central lobe o glabella has a length of $2\frac{1}{4}$ inches. Mr BILLINGS speaks specimen of *Lichas superbus* in which the length of this lobe was 3 inches. If the increase in size of this part was accompanie the same relative increase in the size of the entire animal (and is no good reason for assuming the contrary), such a fragment v represent an individual fully 24 inches in length, a size u passed and unequaled by any other known trilobite.

With his extravagant armor of defense and aggression, *Tera grandis* must have been easy lord of his invertebrate domain an very palatable morsel for the heavily plated fishes of his day.

In the genera PHACOPS and PROETUS great size was never atta The earlier forms of both of these genera were of inconspicuous portions and their maximum size was attained in the middle Devo An entire *Phacops rana* is figured in the Palæontology of New Volume VII, which has a length of 4 inches, and cephala in Museum collection indicate an original length of 5 inches, per the greatest size which has been observed in this genus. PROETU a still smaller habit, that is, its maximum size is never so great, probably, the largest example of the genus recorded is represe by a cephalon of *Proetus macrocephalus* from the Hamilton gr which belonged to an individual fully $3\frac{3}{4}$ inches in length.

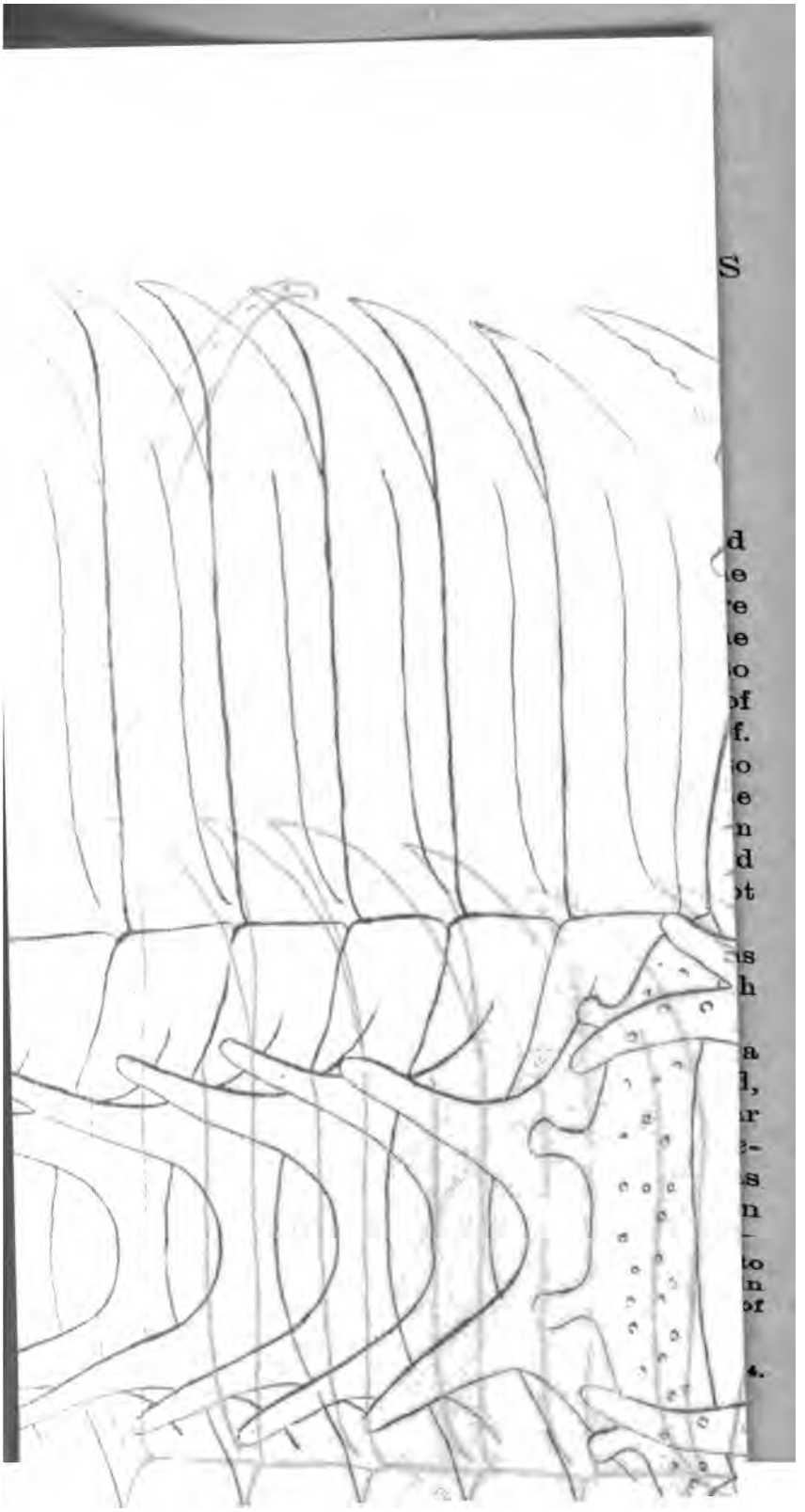


Plate V.

Preliminary Notice of Newberria,* a New Genus of Brachiopods; with Remarks on its Relations to Rensselæria and Amphigenia.

By JAMES HALL.

While making the studies of the brachiopoda described and illustrated in volume IV of the Palæontology of New York, some specimens came into my hands from Waterloo, Iowa, which were described under the designation *Rensselœria? Johannis.*† The generic determination of the species, however, was involved in so much doubt that a suggestion was then made of the propriety of a distinct generic name. Previous to that time, and in 1860, Prof. G. C. Swallow, State Geologist of Missouri, had communicated to me some specimens from Moniteau county, Mo., under the name *Meganteris Missouriensis*, which were apparently identical, in generic characters, with those just mentioned, but as they afforded no satisfactory evidence of the interior structure, they were not discussed at that time.

Further investigation and evidence afforded by other specimens of the Missouri species has determined the generic identity with *R? Johannis.*

In 1867,‡ Mr. F. B. Meek described as *Rensselœria lœvis* a species from the Mackenzie and Onion rivers which appeared, less from the description than from the figures, to be more similar to *R? Johannis* in generic characters than to the typical *Rensselœria*, and in the same publication § Prof. J. H. McChesney has given a rather incomplete account of a form from the Devonian

* This name, with a description of the genus, was communicated for publication to Mr. J. F. Whiteaves, in a letter dated February 5, 1891, which has already appeared in Contributions to Canadian Palæontology, vol. 1, part iii, 5, p. 236, 1891: "The Fossils of the Devonian Rocks of the Mackenzie River Basin."

† *Op. cit.* p. 385, pl. 58a, figs. 9–20.

‡ Transactions Chicago Academy of Sciences, vol. I, pt. 1, pl. xiii, fig. 8; pl. xiv. fig. 4.

§ P. 36, pl. vii, fig. 2.

rocks (Oriskany sandstone), five miles north of Jonesboro, Illinc *Rensselœria Condoni*,* which may prove, when better understo to be of the same type of structure.

This was essentially the condition of our knowledge of the forms until 1883, when Prof. E. W. Claypole published‡ account of a supposed RENSSELÆRIA from the sandstones of t Hamilton group of Perry county, Pennsylvania, and which compared with the Oriskany species from Cumberland, Marylar *R. Marylandica*, Hall. By the kindness of Prof. Claypole I ha been permitted to examine these specimens. While clearly ide tical in generic characters with *Rensselœria? Johannis* from Wat loo, Iowa, they retain the important details of internal structu in an excellent condition, and have thus proved admirable subjec for study and illustration.

With these excellent representations of the Iowa, the Missou and the Pennsylvania species in my possession there seem ample means for the proper illustration of the generic characte of this group; and this work had been undertaken and the dra ings nearly completed when, in the spring of 1890, I was sho by Mr. Whiteaves some very fine and large specimens of tl genus from the "Ramparts" on the Mackenzie river, which has identified with Meek's *Rensselœria lœvis*. These, too, by t favor of Mr. Whiteaves, have been made accessible for study a illustration, and from an examination of all this material t following diagnosis has been drawn:

NEWBERRIA,‡ Hall, 1891.

DIAGNOSIS. Shells elongate ovoid, having the general contc and external aspect of RENSSELÆRIA and AMPHIGENIA, but withc the strongly radiate-striate surface prevailing in the former gen and occurring less strongly developed in the latter. The greate convexity of the valves is in the umbonal region, or above t middle of their length, and in some forms the surface is distinc

* This species was previously described without illustration by Prof. McChesney i pamphlet entitled "Descriptions of New Species of Fossils from the Palæozoic Rock the Western States." 1861.

† Proceedings American Philosophical Society, vol. xxi, No. 114, p. 235.

‡ Dedicated to John S. Newberry, M. D., LL. D., Professor of Geology and Palæontol in the School of Mines, Columbia College, New York, and lately State Geologist of Ol as a mark of appreciation of his high scientific attainments, and in remembrance c friendship which has continued uninterrupted during fifty years.

flattened over the lateral slopes leaving the median portion of the valves very prominent and sometimes subangular.

The pedicle-valve has the rostrum produced and incurved, the apex slightly truncated by the subcircular encroachment of the triangular foramen, which is otherwise concealed; deltidial plates not determined. The teeth are comparatively small, projecting forward and gently upward, free at their extremities, and supported by narrow dental plates, which join the bottom of the valve above the middle of its length and are continued forward as slender, widely divergent ridges upon the inner surface, gradually merging into the shell.

In the bottom of the rostral and umbonal cavity is a broad, usually ill-defined muscular area from which radiates a series of vascular ridges and depressions extending into the marginal region of the valve. The diductor scars are situated posteriorly and deeply impressed; between and in front of them is a narrow, elongate adductor scar which is rarely divided medially and often extends forward to or beyond the center of the valve. On each side of the muscular impression is a thickened area, very narrow at its origin in the rostral region or pedicle-cavity, and produced into divergent ridges, usually two on each side and a fifth in the median axis. These may extend to the margins or disappear before reaching the middle of the valve and are variously subdivided by vascular grooves and sinuses emanating from them.

In the brachial valve the hinge-plate is small, similar to that of TENSSELÆRIA and AMPHIGENIA in general form, but is of relatively less size than in the former genus and is not perforated by a visceral foramen opening beneath the apex. Two very narrow, almost linear and closely submarginal dental sockets extend nearly to the apex; within them lie two broad, subtriangular crural plates which are divided by a triangular median fissure extending to the bottom of the valve. The inner anterior angles of these plates bear the slender crural processes, the extent of which is not known. In mature individuals the apical portion of the hinge-plate is peculiarly constructed; the lateral areas become more or less completely united, without altogether obliterating the median triangular fissure, and above this point the surface is excavated into spoon-shaped cavity, when the development is extreme, or is transversely geniculated in the average individual. At a short distance from the hinge-plate and in the bottom of the

valve there arises a low median ridge, which continues for a short distance separating the obovate narrowly flabelliform scars of the anterior and posterior adductor muscles. The anterior scars are of considerably the larger and their surface is longitudinally striated. The vascular grooves and ridges are more obscurely developed than in the pedicle-valve.

Shell substance finely punctate.

Surface smooth or covered with fine concentric lines accompanied by rugose wrinkles of growth. The inner laminæ are sometimes marked by obscure radiating striæ near the margins of the valves.

Type. *Rensselœria? Johannis*, Hall.

OBSERVATIONS. Several species of RENSSELÆRIA have an essentially similar form to these here described. As a rule, however. the latter are more elongated and none have the radiating surface striæ occurring in both RENSSELÆRIA and AMPHIGENIA. In the latter genus the high dental lamellæ bounding the muscular impressions of pedicle-valve are supported by a median septum; in RENSSELÆRIA this supporting septum is wanting, the convergent lamellæ resting on the bottom of the valve. In NEWBERRIA, however, these lamellæ are exceedingly divergent and quite short, the muscular impression being sunk in the shell substance without other delimitation. Herein the structure is more similar to that in *R. Suessana*, Hall, than to the arrangement occurring in the typical species, *R. ovoides*, Eaton. In typical forms of RENSSELÆRIA as well as in AMPHIGENIA the hinge-plate is not deeply divided medially and is traversed by a visceral foramen, though the latter frequently becomes closed after maturity. In NEWBERRIA the material at hand furnishes no evidence of this perforation, and indeed it could not co-exist with the median triangular cleft in the hinge-plate. The peculiar apical structure of this plate described above has not been seen in allied genera. The strong development of vascular sinuses in NEWBERRIA is a feature of distinction: in *Rensselœria* they rarely appear, and then only with a faint development of fine ramifying grooves, usually confined to the umbonal or ovarian areas. The same is true of AMPHIGENIA, in which the sinuses have not been observed over the pallial region except with a slight development about the anterior margins of the muscular area of the brachial valve. While the form of the muscular area in the pedicle-valve of NEWBERRIA is

like that of its allied genera, the difference in the scars of the brachial valve is more pronounced.

This genus seems to be a later modification of the type of brachiopod structure earliest exemplified in RENSSELÆRIA, and it represents the last appearance of this type. The true RENSSELÆRIA probably closed its existence with the disappearance of the fauna of the Oriskany sandstone; AMPHIGENIA is not known in faunas succeeding those of the Upper Helderberg, while NEWBERRIA occurs in the middle and later Devonian, and is possibly not of earlier age.

DESCRIPTIONS OF THE KNOWN SPECIES OF NEWBERRIA.

NEWBERRIA? CONDONI. McChesney (sp.).

Rensselæria Condoni. McChesney, Trans. Chicago Acad. Sci., vol. 1, pt. 1, p. 36, pl. vii, fig. 2, 1867.

This name is introduced simply to indicate the possibility of this species being an early representative of the genus. It was described from Jonesboro, Illinois, a horizon regarded by Meek and Worthen as essentially equivalent to that of the Oriskany sandstone of New York. McChesney figures the exterior of a smooth shell having about the outline of *Rensselæria Suessana*, Hall, and a partial cast of the interior of the brachial valve showing the longitudinally striated anterior adductor muscular scars of NEWBERRIA.

NEWBERRIA LÆVIS (Meek), Whiteaves.

Rensselæria lævis, Meek. Trans. Chicago Acad. Sci., vol. 1, pt. 1, p. 108, pl. viii, fig. 8; pl. xiv., fig. 4, 1867.

Newberria lævis, Whiteaves. Contrib. Canad. Palæont., vol. 1, pl. iii, 5, p. 237, pl. 30, figs. 3, 4, 4a, 1891.

Not *Rensselæria lævis*, Hall. Pal. N. Y., vol. III, p. 256, pl. xl, fig. 2a-b. 1859.

"Shell rather above medium size, longitudinally ovate or subelliptic in outline, moderately convex in young examples, and very gibbous in adult specimens; front generally rather narrowly rounded; lateral margins forming broad semiovate or semielliptical curves, not inflected. Dorsal valve a little less convex than the other; beak incurved. Ventral valve most convex somewhat behind the middle; beak small, moderately prominent, and

closely curved over that of the opposite valve; foramen small, surface smooth, with a few very obscure traces of ridges of growth. Some of the specimens also show, under a magnifier, very faint indications of radiating striæ, but it is not clear that they are surface markings.

"Length of a medium sized adult specimen, 1.77 inches; breadth, 1.13 inches; convexity about 1.10 inches. Smaller specimens proportionally less convex." (Meek, *op cit.*)

Mr. Meek stated that his specimens from the Mackenzie river and elsewhere were from rocks "possibly older than the Hamilton group," but Mr. Whiteaves' specimens are associated with *Stringocephalus Burtini* and other characteristic middle Devonian species.

NEWBERRIA JOHANNIS, Hall.

Rensselœria? Johannis, Hall. Palæontology of New York, vol. iv, p. 385, pl. lviii A, figs. 9-20. 1867.

Shell oval or subovate and in full grown individuals elongate oval; valves subequally convex.

Pedicle-valve, in young specimens, more gibbous in the upper part, sloping to the front. In older shells the valve is regularly convex, sometimes prominent or subangular along the middle; the beak closely incurved over that of the brachial valve sometimes exposing the apex of the delthyrium.

Brachial valve regularly convex, in old shells acquiring nearly the same convexity as the opposite valve; occasionally depressed and somewhat transverse posteriorly.

Surface marked by concentric striæ of growth, which, at intervals, are crowded into stronger ridges or imbricating folds.

Shell structure finely punctate.

The muscular impressions, vascular ridges and hinge plates are characteristically developed as described in the diagnosis of the genus, but in this species, as also in *N. lœvis* and *N. Missouriensis*, these features do not attain the extreme development manifested in *N. Claypolii*.

The original specimens of this species were from the Hamilton group* of Waterloo, Iowa. It also occurs in the same horizon at or near Buffalo, Iowa.

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*At the time of writing the original description of this species it was supposed that the limestone of Waterloo and Buffalo, Iowa, was of the age of the Upper Helderberg. Later investigations show that in its entire fauna it corresponds to the Hamilton group of New York.

NEWBERRIA MISSOURIENSIS, Swallow sp. in MS.

Meganteris Missouriensis, Swallow in manuscript, communicated 1860; F. B. Meek, collector.

Shell elongate oval; valves convex, usually gibbous in the umbonal region, sometimes depressed. Brachial valve equaling if not exceeding in convexity the opposite valve.

The convexity of both valves is greatest in the median axis, the slopes to the lateral margins being quite abrupt; over the pallial region there may be a slight median flattening on both valves.

Umbo of the pedicle-valve quite pronounced, more so than in the other species.

Surface of both valves smooth, without evidence of concentric wrinkles.

Interior markings, muscular scars and vascular ridges and furrows having about the same degree of development as in *N. Johannis*.

This species is a larger, more robust and rotund shell than *N. Johannis* and is less elongate and more turgid than *R. lævis*. It is from rocks of the age of Hamilton group in Moniteau county, Mo.

NEWBERRIA CLAYPOLII, nom. nov.

Rensselæria compare *R. Marylandica* Hall, Claypole. Proc. Amer. Philos. Soc. p, 235, 1883.

Shell variable in outline, immature specimens being subcircular or broadly subovate, adult individuals elongate, broadest posteriorly and tapering gracefully to a narrow anterior extremity. Valves convex, the pedicle-valve being much the deeper, the greatest depth in both being attained at or about the middle of the valves. The margins are slightly inflected along the lateral edges, as in some species of RENSSELÆRIA. Umbones not prominent nor greatly incurved.

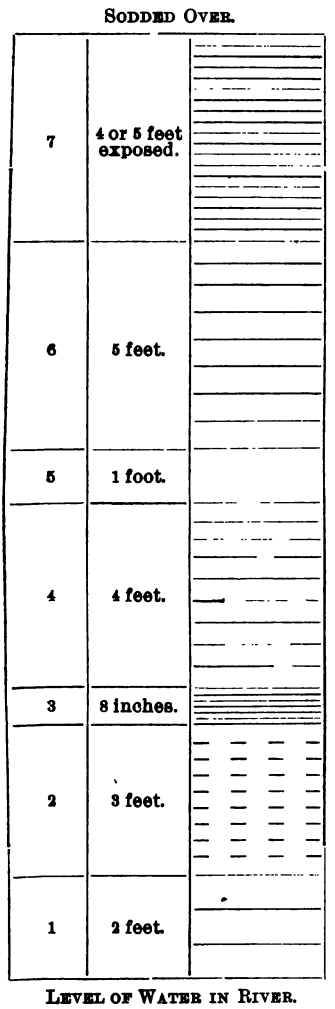
The interior characters, as described in the diagnosis of the genus, are all very strongly developed; the muscular scars are deeply impressed and sharply subdivided into their components, the radiating vascular ridges and furrows are retained in every specimen of the pedicle-valve, though less clearly defined in the opposite valve, and in this species only has the peculiar modification of the hinge-plate already described been observed, a fact probably due to the imperfect or unfavorable preservation of other specimens.

The surface of the shell is covered by fine concentric striæ accompanied by coarse rugæ. It is the most rugose of any of the species here discussed.

The specimens representing this species are sharp internal casts and occur in great numbers in Prof. Claypole's material. They are from a bed near the middle of a series of sandstones in Perry county, Pennsylvania, referred by Claypole to the age of the Hamilton group. The species also occurs in a coarser sandstone at Pine Grove, Schuylkill county, in the same State.

SECTION ON WEST SIDE OF WAPSIPINNICON RIVER, ABOUT ONE-QUARTER MILE BELOW THE DAM AT LITTLETON, IOWA.

(COMMUNICATED BY PROFESSOR S. CALVIN, IOWA CITY.)



1. Limestone with *Cystiphyllum americanum.*
2. Beds containing *Cystiphyllum, Acervularia profunda,* a few specimens of *Spirifera pennata,* Owen.
3. Thin layer of yellow shaly limestone, with *Newberria Johannis, Terebratula Romingeri* and *Pentamerella arata.*
4. Rather hard, dark granular limestone, with *Spirifera Parryana,* large, long-hinged *Strophodonta demissa, Atrypa reticularis.*
5. Compact reef of *Acervularia Davidsoni,* with many species of *Favosites,* a *Chonophyllum, Cladopora prolifera* and *C. palmata.*
6. A bed of indurated shales, somewhat barren of fossils.
7. Yellow argillaceous shales with large *Strophodonta demissa,* a very coarsely ribbed *Atrypa reticularis,* a small *Cyrtina Hamiltonensis, Striatopora rugosa, Orthis suborbicularis* related to *O. impressa, Terebratula* sp?, a small *Rhynchonella, Athyris vittata,* rare, a well marked variety of *Spirifera Parryana,* probably a new species, etc.

1, 2 and 3 of this section are the equivalent of No. 5 of my paper in American Geologist of September, 1891; 4 and 5 equal 6 of that paper, and 6 and 7 equal 7.

EXPLANATION OF PLATE V.

NEWBERRIA CLAYPOLII, *sp. nov.*

Fig. 1. An internal cast of the pedicle-valve; showing the divergent impressions of the dental lamellæ. The irregularly, and probably to some extent, accidently divided scar of the diductor muscles. The narrow anterior adductor and the strong vascular impressions.

Fig. 2. An internal cast of a smaller pedicle-valve in which the impressions of the vascular sinuses are very strongly developed.

Fig. 3. A portion of the interior of the brachial valve, drawn from a gutta-percha impression of a natural internal cast; showing the division of the hinge-plate and the striated anterior and the adductor impressions.

Fig. 4. An internal cast of a brachial valve preserving the usual elongate oval form of mature individuals and showing the muscular and vascular impressions.

Fig. 5. The interior of a pedicle-valve, from a gutta-percha impression; showing an open delthyrium, the divergent dental plates, the muscular and vascular impressions.

Fig. 6. An internal cast of the brachial valve; showing the impression of the apical cup-shaped depression of the hinge-plate. By the removal of the filling of the dental sockets the cardinal slope is made to appear unusually large.

Fig. 7. An internal cast of a large and symmetrical pedicle-valve.

Fig. 8. An internal cast of a large, somewhat deformed brachical valve, which shows the usual size and the division of the hinge-plate.

Fig. 9. An internal cast of the pedicle-valve in which the muscular scars and vascular sinuses, both primary and secondary, are highly developed.

From the sandstone of the Hamilton group. *Perry county, Pennsylvania.*

NEWBERRIA MISSOURIENSIS, *Swallow.*

Figs. 10 and 12. Opposite sides of an individual from which the shell is partially exfoliated, exposing the muscular and vascular impressions, in the pedicle-valve.

Fig. 11. Profile of a large, gibbous individual.

Hamilton group. *Moniteau county, Missouri.*

Plate V.

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EXPLANATION OF PLATE VI.

NEWBERRIA JOHANNIS, *Hall.*

Fig. 1. The exterior of the pedicle-valve of an individual of medium size.

Fig. 2. An internal cast of the upper portion of a brachial valve, showing the impression of the divided hinge-plate and of the adductor muscular scars.

Fig. 3. An internal cast of a similar portion of the pedicle-valve, with the muscular and vascular markings indistinctly retained.

Fig. 4. The exterior of the pedicle-valve of an unusually broad example.

Fig. 5. Front view of a small individual.

Fig. 6. Profile of the same specimen.

Figs. 7, 8, 9. Three views of the exterior of a somewhat broken specimen, showing the triangular delthyrium and the obscure median angulation of both valves.

Figs 10, 11. Views of opposite sides of a large and characteristic specimen, showing the elongate-oval form; the decided median angulation of the valves and the rugose concentric growth of the surface.

All the foregoing specimens are from rocks of the age of the Hamilton group. *Waterloo, Iowa.*

NEWBERRIA LÆVIS (Meek sp.), *Whiteaves.*

Fig. 12. Profile of an individual retaining the shell and showing the normal convexity of the valves.

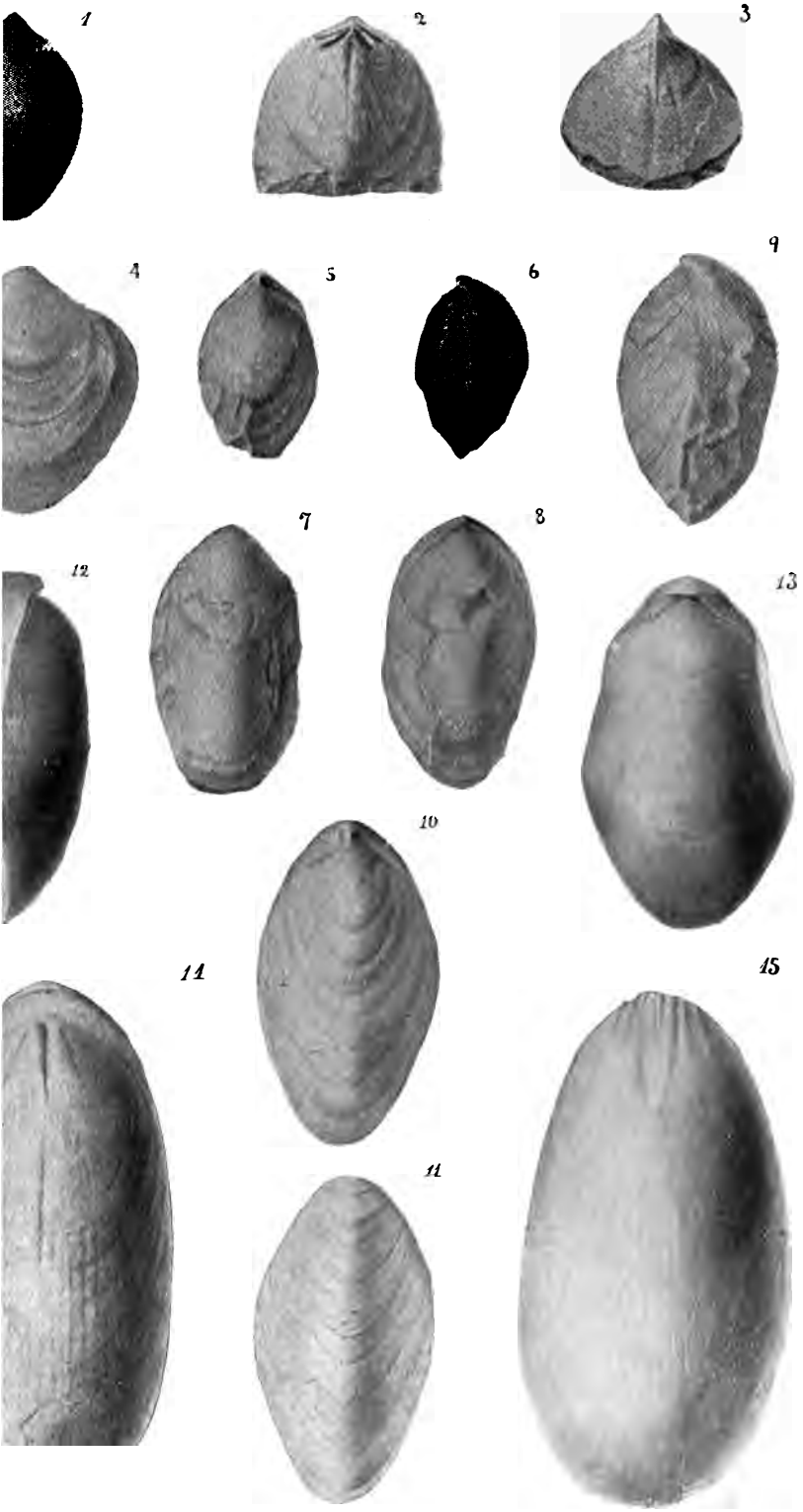
Fig. 13. View of the same specimen from the brachial valve.

Fig. 14. An internal cast of a very large and symmetrical individual, showing the striated anterior adductors and traces of the vascular impression. The fine radiating striæ near the anterior margin of the valve belong to the inner laminæ of the shell.

Fig. 15. The opposite or pedicle-valve of the same specimen, showing the elongate muscular area and the casts of vascular sinuses in the umbonal region.

These figures are made from the specimens described and illustrated by Mr. Whiteaves (*op. cit.* pl. 30, figs. 3, 4, 4a) and are from rocks of the age of the Hamilton group. *Ramparts of the Mackenzie river.*

Plate VI.



Quaternary Geology of the Hudson River Valley.

By FREDERICK J. H. MERRILL.

The following papers on the historic and economic geology of the Hudson River valley form a preliminary contribution to the quaternary geology of that portion of New York State.

The paper on post-glacial history is the result of several seasons' study by the writer.

During the season of 1891 Mr. Heinrich Ries has, under my direction, made a detailed investigation of the region between Croton and Albany and has prepared the accompanying reports on the quaternary deposits in general, the brick clays and the methods of brick manufacture. It is proposed, if means are afforded, to continue these investigations and publish an illustrated report upon the subjects under consideration.

THE POST-GLACIAL HISTORY OF THE HUDSON RIVER VALLEY.

From the post-glacial deposits in the Hudson River valley may be derived much information as to the conditions prevailing therein subsequent to the retreat from its vicinity of the continental glacier.

These deposits are of two general types: Estuary formations of stratified clay and fine sand deposited in still water, and cross-bedded delta deposits of coarser material. They fringe the river shores in terraces between New York and Albany and indicate a long period of submergence, their present altitude above tide showing that the land has been elevated with respect to sea-level since their formation. Their materials were apparently brought into the estuary by tributary streams which dropped the coarser particles near their mouths, while the finer rock flour was carried

on in a state of suspension, and was finally precipitated to form beds of clay.

From Albany westward spreads an alluvial formation which attains at Schenectady an altitude of about 340 feet.

The delta of the Hudson River torrent has not yet been studied by the writer, but it will probably be found in the neighborhood of Sandy Hill. A general description of the estuary deposits of the Champlain period in this region has been given by Professor W. W. Mather (Geol. 1st Dist. N. Y., pp. 148, 149).

Between Poughkeepsie and New York the following streams have formed extensive delta deposits: Wappinger's Creek near New Hamburg, Fishkill Creek, Quassaic Creek at Newburgh, Moodna River at Cornwall, Indian Creek at Cold Spring, Peek's Kill, Cedar Pond Brook and Minisceongo Creek at Haverstraw, Croton River, Pocantico River at Tarrytown, Sawmill River at Yonkers and Tibbit's Brook at Van Courtlandt Park, New York city.

The deposits of Peek's Kill or Annsville Cove, as it is now called, are of considerable interest. These names designate the basin which receives the waters of Annsville Creek, Sprout Brook, and Peekskill Hollow Creek, the last of which carries the drainage of several long and deep valleys trending to the northeast through Putnam County. About the margin of the basin are several terraces about 120 feet high, showing characteristic delta structure, and on the west bank of the Hudson opposite the village of Peekskill and immediately south of Jones' Point is a terrace of coarse gravel which has the same altitude as those on the east bank, and which was at one time regarded by the writer as a portion of the Peek's Kill delta deposit. The coarseness of its material, however, would seem to preclude the possibility of this, and to suggest that it originated as a moraine or a kame and was subsequently terraced in the waters of the estuary. On the flank of Crow's Nest mountain, near West Point, the base of the terrace exposed in the railroad cutting is formed of bowlders of considerable size, and it is suggested by Mr. G. K. Gilbert that this deposit was formed by a lobe of the retreating glacier.

The estuary deposits of the Hudson River at New York indicate a post-glacial depression of more than seventy feet. The terraces which border the west shore of Manhattan Island from Seventy-fifth Street northward have a maximum height of seventy

to seventy-five feet, and on the New Jersey shore of the river, terraces of about the same altitude occur at frequent intervals. One of the most prominent of these is at Fort Lee, south of the steamboat landing. The surface material of these terraces is a fine sand or silt easily transported by the wind. It is evidently not a material which could be laid down in running water, for it would be carried in suspension by a river current and could only be precipitated in the still water of an estuary. North of New York City the altitudes of the terraces have been determined at a few points as follows:

	Feet.
Mouth of Croton River	100
Peekskill	120
West Point	180
Fishkill	210
*Leeds	280
Schenectady	340

A detailed measurement of the terrace altitudes between Fishkill and Schenectady has not yet been made.

On the Long Island Sound shore of Westchester County, N. Y., the till which covers the metamorphic rocks has apparently been leveled off by wave action at an altitude of seventy-five to eighty-five feet. Plains of this character occur at frequent intervals, being separated by river valleys, and were probably formed during the depression which occasioned the estuary deposits of the Hudson river valley. These plains are composed of a modified till, obscurely stratified, somewhat sandy near the surface and comparatively free from bowlders, but unaltered bowlder clay or till occurs at a few feet below their surface. On one of the most extensive of them the village of New Rochelle has been built.

On Staten Island and western Long Island alluvial plains of stratified material rise gently from the ocean shore to the margin of the moraine, terminating at an altitude of about eighty feet, and, though no continuous shore-line is to be found, the plains are referred provisionally to the same period as the estuary deposits a few miles north.

From the evidence quoted the amount of the post-glacial depression at New York is estimated at about eighty feet.

* Prof. Wm. M. Davis, of Harvard College, has recently found the delta of Catskill Creek at an altitude of about 280 feet, near the village of Leeds.

Whether this was subsequent to a greater depression of post-glacial date remains to be determined.

In the estuary which occupied the Hudson River valley during the depression, there was deposited a great depth of plastic clay, evidently a sediment of alluminous rock flour produced by glacial attrition, and held in suspension by the post-glacial streams, and resting upon this clay, is a deposit of fine stratified sand. This bipartite character of the Hudson River estuary formation suggests that two distinct conditions prevailed during the time of its deposition. The clay represents a period of still water deposition when little or no siliceous material was washed into the basin, while the overlying stratified sand was evidently deposited at a time when much siliceous matter was carried in by the tributaries.

The causes of this differentiation are not clearly manifest. If there were good evidence to show that, at the close of the ice-period, there had been a greater submergence of the continental margin than that proven by the delta deposits above mentioned, the hypothesis might be advanced that during this greater subsidence there was but little of the land surface exposed above sea-level in the vicinity of this estuary and consequently but little surface drainage. The larger tributaries fed by waters from the melting glacier would then bear into the estuary a large quantity of rock flour which would be held in suspension for a time and would finally be deposited in the deeper water as clay. As the sand rose from its submergence, however, a larger area would be exposed to surface drainage and would yield in immediate proximity to the basin, an increasing amount of siliceous matter which would be deposited over the clay and constitute the upper member of the estuary formation.

It remains for future investigation to determine the total amount of submergence in this region cotemporary with the last advance of the ice sheet and subsequent to its retreat.

The records of ocean wave action are in many cases different from those of the extinct quatenary lakes and not so easy to recognize. It is not always possible to decide a question of submergence by the presence or absence of a distinct shore-line. On a lake shore wave action tends to cut in an horizontal plane and the result is a series of terraces or a beach plane associated with

shore drift and literal deposits in various phases. When ocean waves act upon a shore there may be two cases:

1. The land may be at rest. In this case the result will be the same as on the shore of a lake which maintains its level for a comparatively long time.

2. The land may be rising or subsiding with respect to sea-level. In this case the plane of erosion will be a resultant of two planar forces: *a*, the wave force which operates in an horizontal plane; *b*, the force of elevation or depression which acts in a vertical plane and subjects to the former successively lower or higher portions of the land margin. According to the relation of these forces or the relation of the rate of land movement to the rate of wave cutting the plane of erosion will vary in its inclination. As the cutting rate relatively increases the plane of erosion approximates to horizontality, and when it becomes infinitely great the plane of erosion will become a base-level. As the cutting rate relatively diminishes, the plane of erosion will become more and more inclined to the base-level and will approach verticality. When the cutting rate becomes infinitely small with respect to the rate of land movement the plane of erosion becomes vertical. In this case a vertical rock face would not lose its verticality by the erosion nor would the slope of the land surface be altered except through variations in the resistance of the rock acted upon.

The degree in which the eroded land surface would approximate to an oblique or vertical plane of erosion would depend upon the previous configuration of that surface. In order to completely discuss this question it would be necessary to consider a large number of incidental factors which might divert the plane of erosion from its theoretic position and prevent the eroded land surface from coinciding with it, but this completeness is unnecessary for the present purpose which is simply to point out the fact that a land surface in process of subsidence or emergence may be subjected to wave action without being incised with distinct shore lines, and also that *wave action may produce an inclined plane as well as a terrace or a base-level.*

It is therefore evident that submergence would not leave a deeply cut short-line as its record unless the rates of land movement and wave cutting were so adjusted as to permit of it. In

fact, no very distinctly cut shore-lines are to be found on the drift about New York even at an altitude corresponding with that of the Hudson estuary deposits. Apart from the still water deposits the 80-foot post-glacial depression about New York can only be traced by change of surface slope and material at this level. Even these two varieties of evidence are not always co-existent.

There are in Westchester county and on Long Island indications of wave action on the glacial drift at altitudes of 150 to 180 feet, it remains to be determined whether they are reliable.

The present condition of the quaternary deposits in the Hudson valley is indicative of fluviatile erosion in post-Champlain time. The estuary deposits and deltas have been eroded and truncated until but a narrow fringe is left of formations which once extended far across the valley or filled it, and the water in the channel of the river has now a depth varying from fifty feet in the shallower portions to 180 feet in the deepest parts.

The delta deposits have also been subjected to the erosion of the streams which formed them and which developed cutting power as the land rose from its submergence. This erosion removed a large portion of the deposits and excavated channels through them below present tide-level. The mouths of the tributary streams are now generally silted up and the process of filling seems to be going on at present. It seems indisputable that the brick clay deposits once filled the entire valley up to a certain level, and that the present depth of the channel of the Hudson is due to the erosion of the still water deposits by a river current. It is also, probable that in the narrow gorge of the Highlands some of the deltas filled the valley, but this point has not been fully determined.

Between Poughkeepsie and Albany at many points near the water's edge are steep, unglaciated rock surfaces much fresher in appearance than the glaciated surfaces upon which the Champlain deposits rest. These may be the result of river erosion subsequent to the formation of the terraces.

The evidences of fluviatile erosion enumerated suggest a rapid flow of water down the Hudson valley in the late quaternary. Such a flow doubtless began when the valley rose from its submergence. With these evidences of erosion may be correlated the gorge of the Narrows at the entrance of New York harbor. This is a gap in the terminal moraine about 240 feet deep and one

mile wide at tide-level and there is no evidence that it could have resulted from non-deposition of the drift. The bottom of the present channel has a maximum depth of 100 feet below tide-level, and this amount represents the minimum measure of the erosion, since there is probably a considerable accumulation of silt in the old river bed.

It seems highly improbable that the present navigable channel of the Hudson could have been excavated to its present depth in the Champlain deposits by any agency except that of a river current,* and taking the maximum depth of the channel in the Narrows as an example of this erosion we have the amount of post-Champlain subsidence suggested as about 100 feet in the vicinity of New York.

Observations on the coast of New Jersey and Long Island have well established the fact of recent subsidence which can be measured to the extent of twenty feet, by submerged tree stumps. The evidences of fluviatile erosion in the Hudson valley suggest that this may be not more than one-fifth of the total amount.

From the evidence quoted it may be stated provisionally after the retreat of the continental glacier from the Hudson River valley, the land stood for a long time at a lower level than at present. What the maximum of depression amounted to is not known, but in the vicinity of Albany the minimum depression amounted to about 340 feet and at New York to about 80 feet. Next occurred a gradual elevation of the land amounting to 180 feet or more at New York and at Albany to an amount undetermined, but probably not less than 350 feet and perhaps 400 feet or more. During this elevation occurred extensive erosion of the Champlain estuary deposits in the river valley and subsequently followed a depression which has amounted to at least 100 feet at New York and which is apparently continuing at the present day.

As the land rose from its 80-foot depression at New York there seems to have been a brief period of less rapid elevation during which a second serious of estuary terraces and alluvial plains were formed which now stand about twenty-five feet above tide-level. These have been recognized as Staten Island by Dr. N. L. Britton and may be seen on the Harlem River near Fordham Heights and at various points on the Long Island Sound shore of Westchester County.

* See J. D. Dana, this Journal, vol. xl, p. 435.

THE QUATERNARY DEPOSITS OF THE HUDSON RIVER VALLEY BETWEEN CROTON AND ALBANY, WITH NOTES ON THE BRICK CLAYS AND THE MANUFACTURE OF BRICK.

By HEINRICH RIES.

DETAILED ACCOUNT OF THE QUATERNARY OF THE HUDSON RIVER VALLEY BETWEEN CROTON AND ALBANY.

These deposits consist, as stated by Dr. F. J. H. Merrill, of two types. Estuary deposits of fine stratified sand, yellow and blue clay and cross-bedded delta deposits, the material of which is much coarser. The estuary deposits show that the land was submerged for a time, and, by their character, that they were deposited in very quiet water. The different members of the deposit are not always present in any one spot. Sometimes there are only two, but usually three, viz., the blue and the yellow clay and the stratified sand. The clay is usually horizontally stratified but in a few instances dips slightly towards the river. The stratification is usually more distinct and the layers thinner in the case of the yellow clay. At most of the localities where clay is exposed the blue has a much greater thickness than the yellow, and in some places only the blue is present. Again at some localities the layers of the clay are very thin and alternate with equally thin layers of sand or sandy clay. This condition is found at Haverstraw, Stony Point, Fishkill, Cornwall, New Windsor, Croton, Dutchess Junction, Catskill and Port Ewen. At all the above-mentioned localities, except the last two, the clay is overlain by portions of the deltas of rivers tributary to the Hudson at those points, and the alternation of layers may be due to variations of the rapidity of the rivers emptying at those points, and discharging more siliceous matter during periods of overflow. The deltas of Catskill and Rondout Creeks will, probably, be found some distance back from the Hudson near the shore-line of the estuary. In many cases these alternating layers shade into layers of loamy clay which sometimes have a wavy structure. At many points isolated ice-scratched bowlders are found in the clay. Usually the different

members of the deposit are separated from each other by well-marked lines, sometimes, however, the blue and yellow shade into each other. The blue clay is always the lowest member, and is overlain by the yellow. The former is more plastic than the latter and the layers are thicker. Both effervesce readily with acid and hence they are known as marly clays on account of the amount of lime they contain. Both the blue and the yellow are not always present; generally it is the yellow that is missing, sometimes the blue. The clay rests on a bed of gravel, sand, hardpan, bowlder-beds or on the glaciated rock. From Albany to Catskill the underlying material is a dark gray or black sand, with pebbles of shale and quartz. The sand grains chiefly consist of ground up shale, the rest being siliceous and calcareous with a few grains of feldspar and garnet. The sand is used for tempering, but at Catskill contains too much lime for this purpose. The underlying masses of sand and gravel are probably kames. The materials composing them show an obscure cross-stratification in many places. At Coeymans Landing this underlying sand is faulted, and at Fitzgerald's yard at Hudson there are five faults in a space of ten feet. These are probably due to the pressure of the overlying clay. In the upper portion of Sutton and Suderly's bank at Coeyman's Landing there is a patch of stratified, yellowish sand about ten feet thick; but the principal surface covering there and at Coxsackie, Athens, Catskill, Hudson, Stuyvesant and Stockport is from one to three feet of loam. I have not observed these kames of dark sand and gravel to reach a greater height than 90 to 100 feet. They appear to be rounded on top. At Catskill a terrace extends back two miles and probably more; it is deeply incised by Catskill and Kaaterskill Creeks and smaller streams; rocky islands project above its surface at various points. Along the West Shore track, about 150 feet south of the station, the side of the cutting consists of thin alternating layers of clay and sand, twenty-seven feet thick. Above this in places is nine feet of fine stratified yellowish sand. This clay extends along the track for about one-fourth mile till it meets an outcrop of greywacke. On the south side of the Catskill Mountain railroad, some 100 feet from the bridge is an exposure of sand and gravel, the pebbles being very coarse. It is, presumably, drift material, but the exposure is an isolated one and does not show its relation to other deposits of the vicinity. At Smith's dock, on the land of T.

Brousseau, near the river, the upper part of the terrace consists of fine stratified sand, which has been excavated to a depth of twelve feet without striking clay, while farther back in the terrace lies the clay covered by about two feet of loam. The Hudson River shale rises steeply along the water's edge from here down to Malden, and crops out at numerous points in the terrace escarpment. The clay along here is probably not of great depth. Clay is found in the railroad cutting to the north of Malden station, about seven feet above the track-level, and the West Shore railroad traverses a level extent of land from Malden to Mt. Marion, clay being exposed in the numerous cuttings along this stretch.

From Glasco to Rondout the terrace, which is perhaps one-eighth mile broad at Glasco, narrows as it nears Rondout, and has an average height of 150 feet. The clays, so far as could be ascertained lie on the upturned edges of the shale.

At the rear of A. S. Staples' yard there is an exposure of *hardpan* underlaying the clay. The overlying material of this locality consists of sand and gravel, in many instances stratified, and sometimes cross-bedded. The sand in some spots is ten to fifteen feet thick and fine enough to be blown by the wind.

At Port Ewen the clay is mostly blue, resting on a mass of *hardpan*, and in a few places on the glaciated rock-surface. The clay seems to lie as a deposit eighteen to twenty feet thick on the *hardpan* and is in turn overlaid in many places by fine, stratified sand. A point worthy of notice is the difference in level of fifty feet between the terrace at Port Ewen and that at Glasco. This may be due to the fact that when sediment is deposited in a basin, its upper surface will be higher at the edge of the basin than in the center. The quaternary formation broadens out at Port Ewen towards the west and Port Ewen would be on a point of the basin's edge, while Glasco is near the center.

We now come to a narrow portion of the river where the terrace, if present, is of small extent and presumably of drift material.

Where the river broadens out again we come upon clay at Roseton, lying at the head of Newburgh bay. The clay here, nearly all blue, is in a remnant of a terrace 120 feet high, which has escaped entire destruction by the floods of the Hudson valley, owing to its position in a re-entrant angle of the hills along the river. The overlying stratified sand and gravel is ten to fifteen

feet thick. At Jover's upper yard the clay rests on the glaciated limestone, scattered over the surface of which are several bowlders of the same rock. The clay here is 180 feet thick, while at Rose's yard, adjoining on the south, it is 243 feet thick. The boring of 135 feet made at Rose's yard is of interest in connection with the depth of the ancient channel of the Hudson. The pebbles of the overlying gravel are mostly limestone and shale.

About 800 feet south of Roseton Station, the material under the terrace is a yellowish loamy clay, thinly stratified. This may be a portion of the secondary cone of the delta of Wappinger's Creek at New Hamburgh. North of this a cutting has been made in the terrace, the section thus exposed showing the terrace to be composed at this point of alternating irregular layers of yellow and black sand. On top is a loamy clay, the same as that mentioned above.

From Newburgh to New Windsor the clay is overlain by the extensive delta deposits of Quassaic Creek and Moodna River. To the east of Mrs. T. Christie's yard the clay, which is mostly blue and thin-layered, is overlaid by fine gravel and sand obscurely cross-stratified in places. Over this is three to four feet of sandy soil. The upper layers of the clay are wrinkled in places, probably owing to the oblique downward pressure of the overlying delta deposits. It seems likely that at this spot only a small portion of them remain, much having probably been washed away. At Lang's yard, south of Christie's, there is four to six feet of sand and gravel over the clay of the same nature as that previously mentioned. Scattered all through the clay are cobbles of limestone. The upper strata are loamy and contorted, while underneath, in the yellow clay, which is very tough, the stratification is almost entirely obliterated. At the next bank, also belonging to Lang, there is six feet of overlying sand and gravel. Scattered through the clay are several bowlders of Calciferous sandrock, sandstone, black crystalline limestone and gneiss. The overlying material is mostly unstratified and many of the pebbles are eight inches in diameter. At the bank of J. T. Moore, the clay is very tough, and the stratification is obliterated in spots.

Several ice-scratched bowlders are found in the clay, of light-bluish limestone, sandstone and calciferous sandrock. In Moore and Lahey's bank the clay is tough and compressed, similar to the other yards. It likewise contains scratched bowlders, especi-

ally of a light-blue crystalline limestone. Over the clay is two to four feet of coarse sand and gravel.

On the west side of the New York, Ontario and Western railroad, where it branches off from the West Shore railroad, a cutting in the hillside shows a cross-bedded yellowish sand and loamy clay, with patches of gravel and cobblestones in it. Following along the track, a few hundred feet, we come to the clay bank of C. A. and A. P. Hedges. This shows an interesting section of blue clay, overlaid by fifty to sixty feet of cross-layered delta deposits of sand and gravel. The clay layers are obliterated in spots and in others much contorted. To the north of Hedge's yard in the railroad cutting the clay is overlaid by five to six feet of sand and coarse stones, unstratified. Following up the track on the left side, just beyond the crossing of the road from Canterbury to New Windsor the embankment of sand and coarse gravel is cross-stratified, being presumably a portion of the delta of Moodna River. The character of this embankment changes after about 400 feet to unstratified drift, containing bowlders. This probably underlies the delta material. The upper terrace at Cornwall is composed of drift, containing bowlders. Its structure is well shown along the track at Cornwall Station. There is a small deposit of clay at Cornwall, in a meadow opposite the Roman Catholic church. It was exposed by the digging of trenches for drainage. Near this locality but a little lower down were found some bones, said to be those of a mastodon.

At Jones' Point there was formerly a small deposit of clay but it has been entirely worked out.

Haverstraw has three terraces, at twenty, sixty, and 100 feet. The clay, so far as known, is only found in the two lower ones, the upper one being composed of drift and delta deposits.

There is a deposit of clay at Stony Point forming a portion of the twenty-feet terrace. The upper layers of clay are in places loamy and undulating. Over the clay is a mass of unstratified material from two to eight feet thick, the upper surface of the clay is uneven. The overlying unstratified material is a coarse sand, full of cobblestones of gneiss, schist and granite, all of them rounded but not scratched. On the hillside to the west of this deposit is a large isolated bowlder of granite. The upper terrace at Stony Point is about seventy-five feet higher than the station level; a portion of this terrace remains about one-eighth of a mile

north of Stony Point station on the west side of the track. On the west side of the track where it crosses Cedar Pond brook the delta structure is observable in the embankment, the upper portion of which consists of coarse sand, pebbles and cobblestones which are mostly of gneiss. The lower layers exposed at this point are quite clayey. A short distance below the West Haverstraw station and some 500 feet west of the track, an excavation has been made for tempering material. It exposes a fine yellowish cross-stratified sand overlain by several feet of coarse sand and cobblestones.

In T. Malley's clay bank along the shore on the north side of Grassy Point, the clay does not reach above tide level, and is overlaid by three to four feet of fine gravel. To the northeast of P. Brophy's yard is the remnant of a terrace. It is composed of obscurely cross-stratified sand and gravel, overlaid by a few feet of loamy clay, very thinly stratified and the layers wavy. There is a bowlder of norite in this bank, there are also cobblestones of diorite, gneiss and red sandstone. It may be part of a kame. About 600 feet to the west of the yard of D. Fowler, Jr., & Washburn, the clay is being excavated from beneath the terrace which is here forty-five to fifty feet high.

It is mostly blue, thinly stratified and overlaid by obscurely stratified gravel and sand. In this excavation was a small ice-scratched bowlder which had been found in the clay a few days previous. At J. Brennan's yard the clay is overlain by two to three feet of fine sand, and on this is a layer of indistinctly stratified fine gravel six to seven feet thick, with a covering of one foot of soil. The terrace at this point is about fifty feet high. Cobbles one to two feet in diameter of granite, gneiss, and pegmatite were found in this bank. Farther south at Peck's yard, several bowlders of syenite, granite, limestone, and sandstone were found in the clay. Those seen were in the lower portion of the bed, but I was told that several had been found in the upper portion.

Along the river behind the yards of the Excelsior and Diamond Brick Companies, most of the overlying material has been removed, but judging from what is left it must have been ten to fifteen feet thick.

South of Haverstraw the contact of the clay with the underlying drift can be observed, the clay thinning out as it

approaches the hill. Some two miles south from Haverstraw, and half way between the stations of Ivy Leaf and Thiells, on the New York and New Jersey railroad, in the valley of Ivory Creek, is a basin-shaped deposit of clay belonging to E. W. Christie.

It is not over fifteen feet thick as determined by boring, and has a slightly elliptical outline. The valley in which it lies is full of glacial material, and contains numerous kames, whose longer axis lies parallel to the direction of the valley. A view of one near the clay deposit is shown.

The clay is underlain by drift material containing bowlders of quartzite, calciferous sandrock, granite, sandstone, gneiss and schist. Over the clay is one to two feet of sand containing large ice-scratched stones of quartzite, gneiss and schist. This clay deposit was probably formed in a small lake. If it were a portion of the Hudson river estuary deposits it would indicate a much greater submergence than that of 100 feet supposed for this region, for this locality must be fully 200 feet above the level of the Hudson river. On either side of the track at Thiells are probable remnants of a terrace.

The clay bank of the Anchor Brick Company, at Croton Landing, is elliptical in outline and lies on a bed of granite, gneiss, schist and white crystalline limestone pebbles, cemented together by clay, covered with limonite. Large pebbles are scattered through the clay, the layers of which are undulating, conforming to the shape of the underlying surface. Over the clay is four to five feet of gravel and sand. South of this yard an excavation has been made under the terrace for obtaining gravel. The embankment beneath the terrace at this point is made up of delta deposits, but projecting up into it is a mass of unstratified gravel and sand containing bowlders. It is presumably a portion of the underlying drift.

At the end of the point are the clay pits of the Underhill Brick Company. Their clay is overlaid by delta sand evidently derived from the crystalline rocks of the surrounding country. Some of it is quite yellow, and contains numerous grains of mica. Scattered through this sand are great numbers of botryoidal sand concretions, some of them forming masses six feet long and three to four feet wide. They show the layers of deposition of the sand.

ıe clay at Crugers, Montrose and Verplank, lies in hollows ped in the rock by the ice, being as much as fifty feet thick in ɔ places. At Crugers it is overlain by a few feet of loam; at ıtrose by stratified sand varying in depth from five to twenty- ·n feet according to borings made. Along the Hudson River rail- l track, below Montrose, at Morton's yard, the clay is overlain by ·n eight to ten feet if fine gravel, and sand, cross-stratified and · dark gray or black color. The materials composing it are, to a ·ent, ground up crystalline rocks. The same material covers ə clay at McConnell & O'Brien's bank. At the clay beds of the ıdson River Brick Company, at Verplank, the clay is covered v yellowish sand and fine dark-colored gravel; usually they are ustratified but in few spots show cross-bedding.

A short distance below Peekskill, at Bonner and Cole's yard, is remnant of a twenty-foot terrace. There is here a deposit of ıay not extending more than four feet above tide, and overlain by ·n unstratified layer five feet thick, of coarse sand and cobble- tones, mostly gneiss.

From Storm King Station to Dutchess Junction there is a stretch ɔf terrace, which extends back to the foot of Breakneck and Fish- ·ill mountains. The maximum height of it is 210 feet.

Various firms are digging clay in it the greater part of its length. A well of sixty-five feet sunk at Aldridge's yard still showed clay, and adding to this sixty-five feet of clay above the river level, gives us a thickness of 130 feet at this point. The character and thickness of the overlying material varies somewhat. To the rear of Timoney's yard some 700 feet, the terrace has been excavated to a depth of thirty feet, exposing a mass of coarse sand, gravel, and cobblestones, mostly granites, gneisses and schists. A portion of it is stratified, and at the base of the excavation at one point yellow clay has been found. At Timoney's yard there is from one to two feet of loam covered by brush on the top of the terrace. At Van Buren's yard the upper layers of clay alternate with layers of sand; the upper six feet of the terrace at this point is gravel, the pebbles of it being mostly granites and gneisses. At Aldridge's yard the clay is covered by six to eight feet of unstratified gravel and sand, while at another spot on top of his bank are twelve to fifteen feet of fine yellow sand, which shows no stratification. The upper layers of Barnacue and Dow's clay are like those at Van Buren's, but covered by four feet of sand and

over this in places six to eight feet of coarse gravel. Nothing is known of the underlying material at these yards.

The whole of Denning's Point is covered with a fine stratified yellowish sand. The clay, which lies at the base of the point, has a thin covering of loam, and the upper layers are somewhat wrinkled.

There is another stretch of terrace, similar to that below Dutchess Junction and of the same height, extending from one-half a mile above Fishkill to Low Point. At most places the clay is covered by a few feet of loamy soil. Several bowlders have been found in the clay at Brockway's yard. Several feet of sand overlie the clay at Lahey's, Brockway's and Dinan and Butler's yards. At J. V. Meade's yard, a short distance below Low Point, the clay is covered by about three feet of sand, faintly stratified, and above this six to eight feet of unstratified material: coarse sand, pebbles and cobblestones, some of them eighteen inches in diameter. Most of them are Archaean rocks, but there are also fragments of shale, limestone, sandstone and a few of them contained palæozoic fossils. About 1,000 feet south of Meade's yard is a gravel bank eight to fifteen feet thick, of material similar to that overlying the clay in Meade's bank. At the base of this embankment, in a few spots, yellowish clay overlaid by stratified sand has been struck.

The clay deposits of Hudson, Stockport and Stuyvesant are like those at Coeymans Landing, being overlaid in most places by a few feet of loam and underlain by dark sand and gravel. At Stockport two ice-scratched bowlders were found in the clay; one of them three feet in diameter, the other three times as large. To the north of Brousseau's yard at Stuyvesant the surface material is stratified sand, fifteen feet of it being exposed thus far.

The delta deposits of the streams tributary to the Hudson river are extremely interesting. They give us an idea of the size of the rivers flowing into the Hudson valley when it formed an estuary, and also indicate the amount of depression which took place at those localities. All three portions of a delta deposit described by Russell, may be observed in the ancient deltas on the Hudson. They are the thin layers of loamy clay which form the secondary alluvial cone of the delta, the cross-stratified sand and gravel and the overlying unassorted material. This latter was observed at Haverstraw, New Windsor, Low Point and Dutchess Junction.

The following streams between New York and Poughkeepsie have formed delta deposits [as noted by Dr. Merrill*]: Wappinger's Creek, New Hamburgh; Fishkill Creek; Indian Creek, Cold Spring; Peek's Kill; Croton River; Pocantico River, Tarrytown; Sawmill River, Yonkers; Tibbitt's Brook, Van Cortland; Minisceongo Creek, Haverstraw; Cedar Pond Brook, Haverstraw; Moodna River, Cornwall and Quassaic Creek, Newburgh.† At the present day but traces of these deposits remain, and the streams which formed them, have cut down through them below tide-level. Dr. Merrill thinks it highly probable that these deltas once filled a large portion of the valley in the Highlands. At Roseton, as already mentioned, there is a deposit which may have come from the delta of Wappinger Creek. Also at Jones' Point opposite Peekskill there is a terrace composed of transported material, which Dr. Merrill for a while regarded as a portion of Peek's Kill delta; the size of the pebbles composing it, however, caused him to give up this view. There is, however, in the upper portion of the terrace, a layer of unassorted material which is slightly separated from the rest; also at the south end of the terrace a portion of thinly and obscurely stratified loamy clay, which may have formed a portion of the secondary cone of this delta. At Croton, Haverstraw and Cornwall, also at New Windsor, the clay is overlaid by delta material, and where this occurs, especially at Croton, the upper limit of the clay is comparatively low, it having probably been eroded to a certain extent by the river entering the estuary at that point, and again it is not likely that very much clay would be deposited around the mouth of the river on account of the current. This may have been the case below Peekskill.

In general the upper limit of the clay increases northward as does the terrace level. To illustrate this point we have the following altitudes:

East side.		West side.	
Croton	100	Haverstraw	100
Peekskill	120		
		West Point	185
		Cornwall	200
Fishkill	205	Newburgh	205
		Port Ewen	207
		Schenectady	340

* Amer. Jour. Sci., vol. xli, June, 1891.
† See note No. 2.

These measurements apply, of course, to the upper terrace, which can be traced along many portions of the river. At some localities we find more than one terrace, viz.:

Athens	2, a 3rd?
Port Ewen	2
Cornwall	4
Haverstraw	2
Stony Point	3
Peekskill	2
Fishkill	2
Storm King	2
Schodack	2

The altitudes given for the terraces were measured along the river at the brickyards, and in the case of the upper terrace the shore-line is generally some distance back from the river. In fact as we go up the river, especially above Port Ewen, the shore-line recedes. At Port Ewen the terrace is 207 feet, but it must be fully 225 feet at the base of Hussey mountain, which was probably an island in the estuary. The terrace extends up the Wallkill valley several miles. [Mather.]* It seems to me not improbable that a shore-line of this quaternary deposit will be found along the base of the Catskill mountains, or not far from there. At Coeymans Landing the terrace is 140 feet, and it rises to 177 feet at the West Shore railroad station, about a mile from the river; then a hill hides the further continuation of it from view.

From Catskill up to Albany the terrace at most points is very wide. At Coxsackie it extends behind the hill to the south of the town, and comes down along Murder Creek to Athens. From Albany an alluvial plain belonging to this formation spreads westward, reaching a height of 340 feet at Schenectady. The surface of these terraces is usually a loamy soil whose agricultural value will be spoken of farther on, and these terraces are characteristic features of the quaternary deposits. They are found along nearly all the rivers.

Following up Croton River as far as Croton Lake, remnants of terraces are seen at various points, their height above the river-bed decreasing as we recede from the Hudson.

* Geol. 1st Dist. N. Y., p. 131.

The majority of these detached pieces seem to belong to a terrace formed at the same time as the 100-foot one at Croton Landing. There are at a few places traces of a second and lower terrace, and besides this a third one being formed by the river during its floods at the present day.

From the facts as observed quoted above, the following may be deduced. That during the retreat of the ice sheet from the Hudson valley, the glacial streams deposited as kames a great amount of ground-up material, principally shale; the material found underlying the clays along the upper portions of the valley.

That subsequent to the retreat of the glacier there was a depression of the land, which, according to Dr. Merrill, at New York amounted to 80 feet, and at Schenectady to about 340 feet.

During this period a great amount of plastic clay was deposited, produced by glacial attrition of the shales and limestones, the latter no doubt giving to it the marly character and influencing its color. As to the origin of the yellow clay; it is not nearly so plastic as the blue, and appears to contain more siliceous matter. (Sand will destroy plasticity.) It may be that when this yellow clay was deposited the land had risen a little, exposing an area around the basin which would afford a certain amount of siliceous matter. Finally, when the land had risen considerably the velocity of the streams entering the estuary would be increased, the material deposited in the basin would probably be entirely siliceous, and the fine clayey sediment would be washed out to sea.

To account for the isolated bowlders in the clay it seems highly probable that ice-bergs or ice-floes having stones and dirt imprisoned within their mass, detached themselves from the retreating glacier, and, floating down the tributary rivers to the estuary, dropped their burdens.

The unstratified material found with and in some cases overlying the stratified delta deposits, is a matter of interest as concerns its origin. *Two* things may be noticed as regarding it. 1. The material is sand, pebbles and cobblestones lying mixed together without any separation of the coarse from the fine.* 2. The pebbles and stone are rounded and do not show any scratches. 3. The materials are of the same character as the rocks of the vicinity.

* The only locality where stratification was observable, was at Timoney's yard near Dutchess Junction.

Now as the land rose from its submergence, the velocity and with it the transporting power of the streams would increase washing down quantities of large stones and gravel.* Dr. Merrill states that he considers that a rapid flow of water took place down through the Hudson valley in the late Quaternary. This water must have come down through the valleys of the tributary streams, having a much greater velocity in their valleys than they would have after they turned into the Hudson valley. Also the checking of their velocity as they reached the Hudson would cause them to deposit the greater part of their load. A large stream rushing down the valley of the Fishkill would be likely to spread the material brought down by it over the clay deposits above and below Fishkill, especially below it where we find them heaviest as the flow of the water was towards the south.

Again, Peek's Kill would behave in a similar manner.

The different terraces at any one locality were probably caused by the water remaining for a time at different levels during the elevation of the land.

Clay concretions. These are of common occurrence, especially in the yellow clay. They are of varying form and size. However, nearly every one has a cylindrical hole in the center, which is lined with black. The concretions are found parallel to the layers of the clay, and in many instances at a depth from the surface to which the roots penetrate.

Those found at a greater depth did not have the central cylindrical cavity. They are very abundant in the yellow clay at Haverstraw. Roots penetrating the clay at this locality were surrounded by lumps of clay in the form of concentric rings. These might seem to indicate the method of formation described by Prof. J. D. Dana (Manual of Geol. p. 628). Again, in the yellow clay near the surface at Coxsackie, were found some forms which were similar in appearance to what Dr. Northrop has described as rhizomorphs.† They may be due to the roots which penetrate the clay, absorbing water from it and rejecting the contained lime, which deposits itself around the root forming the hard rhizomorph. Their interior structure was crystalline.

Another form of concretion is found in the delta sands at Croton point. It consists of botryoidal masses of sand, presumably

* See note No. 3.

† Trans. N. Y. Acad. Sci. Oct. 13, 1890.

cemented by oxide of iron. Some of them show the layers of deposition of the sand. These concretions are usually small, but one mass was noticed fully six feet long and four feet wide.

Concerning the origin of these concretions various opinions are expressed by different geologists.

LeConte* says that they occur "wherever any substance is diffused in small quantities through a mass of entirely different material. Thus if a stratum of sandstone or clay have small quantities of carbonate of lime or carbonate of iron diffused through it, the particles of lime or iron will gradually by a process little understood, segregate themselves into more or less spherical or nodular masses, in some cases almost pure but generally inclosing a considerable quantity of the material of the strata.

"In this manner iron-ore balls, lime-balls, and nodules so common in the sandstone and clay are formed."

Professor Hitchcock, in the Geology of Massachusetts, believes them to be formed by the crystallization of calcite in clay; that lateral accretion predominates, from the easier movement of the clay of the particles sideways.

Mr. L. P. Gratacap† notices the following facts concerning these concretions:

That in their formation they have passed through a preliminary or soft stage, before hardening more or less.

That the process of a concretion has formed a center about which the others gathered.

That the approach to solidity of a concreting mass is attended with the development of new centers about which concretions form.

That there seems to be a tendency of matter to concrete around a center from all sides equally.

That the concretions lie parallel to the bedding.

The upper surface of the concretion is usually varied while the under surface is flat.

The concretions show periods of growth, and the amount of carbonate of lime in them varies as does also their specific gravity.

Mr. Gratacap, after remarking on the microscopic structure of an oblate concretion which showed a horizontal area in the center densely crowded with crystals of calcite, states that it seems

*Manual of Geology.

†Amer. Nat., 1884.

probable "that in the clay beds where these concretions were formed there were variously-shaped spots, or irregular separations between the layers, where the moisture remained for a long time, keeping the clay in a plastic, more or less liquid form, and that on the withdrawal of the water to these points, the soluble carbonate of lime also gathered there. This latter became concentrated by the concentration of the magma, or through the introduction of more carbonate of lime in solution in percolating waters.

THE HUDSON RIVER BRICK CLAYS.

THICKNESS, EXTENT AND QUALITY.

The deposits of brick clay extend along both sides of the river more or less continuously from Sing Sing to Albany.

There are isolated patches below the former locality but they are not of any great extent. There are two narrow portions of the river from Staatsburgh to New Hamburgh, and from Cornwall to Jones' Point where little clay is found. (Mather, Geol. 1st. Dist. N. Y.)

The embankment in which the clay lies often rises steeply from the shore, and the terrace which the clay underlies extends in some cases, especially along the upper portions of the river, one or more miles from the shore, while at other localities is not over 400 to 500 feet wide. In speaking of the terrace extending back several miles, it is not meant in an unbroken stretch, for numerous ridges of rock project above its surface at many localities.

The thickness of the clays is also very variable, they being underlain by irregular ridges of rock, and rounded hills of stratified drift or kames, or as at Verplank and Crugers, the clay lies in basins scooped out in the rock by the ice.

On the average, the clay is of good quality, and capable of producing a good brick. The Croton Point clays, and portions of those below Peekskill are very "fat" By a fat clay is meant one possessing great plasticity and being quite pure. Again at other localities as New Windsor and Haverstraw, the clay contains numerous patches of quicksand. These patches are generally flat and lie parallel to the clay layers.

There is hardly a clay bank, however, which does not show streaks of quicksand.

Two kinds of clay are found along the river, the blue and the yellow; the former always underlies the latter, and occasionally they shade into each other or are interstratified.

As to the relative qualities of the two, the blue makes a better brick, and does not shrink as much in drying and burning as the yellow. The yellow gives a better colored brick, is tougher than the blue, does not occur in as great quantity and is not as plastic. At some yards only the yellow is used at others only the blue.

Unworked clay was noticed at the following localities: In the escarpment of the terrace to the north of Corwin and Cullough's yard at Coeymans Landing, south of Coeymans Landing. In the face of the bluff along the river just south of Coxsackie. In the enbankment underlying the terrace from Barrytown to Rhinebeck. Underlying the terrace from Athens to Coxsackie. On Catskill creek just north of the West Shore railroad bridge.

The Hudson river clays are, with few exceptions, situated so as to afford the greatest ease and economy of working. The yards are mostly located along the river front, the clay bank being adjacent to them, and at a higher level, so that the haulage of the clay is down grade to the tempering pits. Again, the tempering sand is at many localities found above or below the clay and the location of the greater number of the yards along the river shore, permits of the leading of the burnt bricks on barrows and the wheeling of them directly on the scow, usually a distance of not over 100 feet.

All of the yards along the east shore have the railroad passing by them, but the cost of transportation by rail is usually much greater than that by water. The latter costs one dollar and twenty five cents per 1,000. Along the west shore the only yards accessible to the railroad are those at Roseton, New Windsor, Cornwall and Stony Point. At Cornwall many of the bricks are shipped to points along the New York, Ontario and Western railroad, while at Dutchess Junction, W. D. Budd ships much of his manufactured product on the New York and New England railroad. Even if transportation by rail were as cheap as by water, those yards situated along the railroad would need to have an extra track laid to start the cars on, and in most cases there is not room for this. Many of the larger firms own brick scows, thus saving a certain amount in the cost of production.

COST OF PRODUCTION.

The cost of production along the river is about five dollars and fifty cents per thousand brick. This includes the commission paid for selling them. This figure seems rather high and at present when bricks bring only five dollars to five dollars and fifty cents per thousand there is no profit and even a loss. At the present time the manufacturers who own their clay banks are the least affected by the depression of the market. The cost of production could probably be reduced by the use of more improved methods and machinery, and also in the use of other fuel. For instance a saving of thirty or forty cents per 1,000 might be made by using oil instead of wood for burning, or twenty-five to thirty cents if coal were used. Again, where the haulage distance is great, locomotive haulage is cheaper than cartage. However the use of more and improved machinery, needs a greater outlay of capital than is in most cases available.

Usually the manufacturers own their yard and plant. As to the clay, it is worked on three financial bases.

1. The manufacturer owns the clay himself. This is by far the best and most profitable way.

2. The manufacturer pays the owner of the clay a certain amount of his net profits, usually nine to ten per cent or else a certain rental.

3. The manufacturer pays the owner a certain sum per 1,000 bricks made. At Haverstraw this varies from twenty-five cents to one dollar and twenty-five cents per 1,000. A Verplank manufacturer pays thirty-five cents per 1,000. With this arrangement the manufacturer is bound to make a certain number of bricks.

In some instances the manufacturer leases the clay from one person and the yard and plant from another, and sometimes even subleases them both to a fourth person.

The average annual production of bricks along the Hudson river between New York and Albany amounts to 1,008,000,000; this year it will not reach the above figures as many of the yards have suspended operations on account of the depression in the market.

Haverstraw and Croton produce the best quality of brick.

Those manufactured along the upper portions of the river are said to be not very strong, nor will they stand much handling.

The price of clay land varies according to the quality and thickness of the clay. Good clay land at some points is worth as much as $1,000 per acre.

Although at present only ordinary bricks are manufactured, experiments have been made in other directions, and in some cases these have been successful. These clays will make hollow brick and drain-tile, also a fair quality of sewer pipe.

Enameled brick have been made from the clay on Croton Point. At the time of their manufacture the clay was a trifle too siliceous, causing the enamel to crack slightly sometimes in burning. The clay now being dug at this locality is much purer, but it has not been tried for this purpose.

EXPLOITATION AND WORKING.

Though occurring usually in terraces, still the presence of a terrace does not always indicate clay. For instance, at Haverstraw the clay is obtained from the sixty feet terrace, while the 100 feet one is composed of glacial drift and delta material. In prospecting for clay along the Hudson river there is little difficulty in detecting its presence. It can generally be seen on the face of the terrace escarpment, in road cuttings, or in the sides of gullies made by small streams, which drain the terrace. In some cases the surface consists of sand or gravel, and then this has to be pierced by the auger in order to determine the presence and the thickness of the clay. In determining the extent and thickness at any particular locality, it is of importance to make a number of borings, as sometimes the clay suddenly thins out. Where the terrace is narrow the clay usually thins out as it recedes from the river. Unfortunately, as far as ascertainable, few borings have been made in these clays to determine their thickness, and in most cases they have not been mined below the level of the yard, which is generally eight to ten feet above mean tide.

Having determined, by boring or otherwise, the extent and thickness of the clay at the locality where the brick-yard is to be established, the next step is to strip a portion of the surface to a sufficient depth to expose the clay.

The amount of stripping to be done varies at the different localities. At some it is a foot or two of loam which is mixed with the clay; at others the covering may be of sand which can be used for tempering, or of gravel or cobblestones. Again, sometimes the surface is covered with scrubby trees. These latter, however, are only met with occasionally. In most cases the stripping can be used, especially when a yard is first being started, in which case it is employed for filling.

Having uncovered the clay several methods are employed to mine it.

1. The clay is dug at any convenient spot in the base of the bank, working inward, thus eventually leaving quite a steep face, and the clay being softened by rain and spring water, is not stiff enough to stand thus, and slides. Then the men again work inward at the base. The disadvantage of this method is that the yellow and blue clay become mixed with each other and sometimes with the top material. However, it has the advantage of making the haulage of the clay practically on one level.

2. A second method which is employed at only a few yards, is to loosen the clay by means of plows and then bring it down to the level of the tempering pits by means of scrapers. It costs about twenty cents per 1,000 brick to plow the clay and bring it down with the scrapers. To this must be added the cost of carting the material from the heap to the tempering pits, usually a distance of forty to sixty feet. When this method of mining is used the bank is worked at an angle of about thirty degrees. This method has no special advantage and is only practiced at seven yards. The clay is somewhat more broken up and exposed to the weather for a few days, but otherwise nothing is gained.

3. The third and commonest method, used where the bank is over thirty-five feet thick, is that of working the clay in benches, from six to eight feet wide and seven to nine feet high. Each bench is worked in advance of the next lower one. Roads lead up to the different benches.

Where the clay has streaks of quicksand or is being worked below river-level, the roads have to be laid with planks, and in the latter case there is the additional cost of pumping machinery to keep the clay-pits dry.

4. At Croton the excavating was done, for a while, by means of a steam shovel, but this was unsuccessful owing to the fact that the shovel digs the clay in a vertical face and, the clay not being stiff enough to stand thus, slid down and entombed the shovel.

5. A method of obtaining the clay practiced at present by only one yard, but which will, probably, be tried at others in the near future, is that of dredging the clay from the river. The clay thus dredged is dropped into hoppers which, when full, are run on shore and dumped.

6. The yellow clay being quite tough is usually worked by the pick, but very often if the stratum of it is not over twenty feet in thickness it is worked by undermining. Wedges are driven in on the upper surface a foot or two from the edge causing a large piece of the bank to fall. This method is not considered advisable for a bank of any great thickness, on account of the danger from the falling clay.

The clay is hauled from the bank to the tempering pits usually in one-horse carts. The hauling distance is usually from 150 to 200 feet. At Kline's yard at Port Ewen, the haulage distance varies from 600 to 900 feet, down grade. At Griggs' yard at Low Point it is 500 to 600 feet. At New Windsor, 200 to 250 feet. At Anchor Brick Company at Croton, 500 to 600 feet. Underhill Brick Company about 400 feet. Those yards at Verplank obtaining their clay from the Hudson River Brick Company, have to transport it about half a mile. At Haverstraw the yards situated on Minisceongo creek have to haul their clay a distance of one-eighth to one-fourth or even in some cases half a mile. For long haulage distances as 400 feet or more it is cheaper to lay a track to the bank and use cars drawn by horses or a small engine, preferably the latter if the scale of operations warrants it. Locomotive haulage of clay costs about five cents per 1,000 bricks [about one and one-quarter to one and one-half cubic yards being reckoned to 1,000 bricks] for 600 feet. Dredging the clay from the river costs twelve to fifteen cents per 1,000 bricks delivered on shore. Then there is the additional cost of about twelve cents to haul it to the tempering pits. At some yards where the clay lies on top of the cliff and the yard is situated at the base, the clay is hauled to the edge of the cliff and sent down a shute to the tempering pits.

Digging the clay costs about twenty-five to thirty cents per 1,000 bricks. To plow the clay and bring it down by scrapers cost about twenty cents per 1,000 brick, making a total of about thirty cents per 1,000 brick delivered at the tempering pits. Haulage by horse cars up grade a distance of 400 feet cost fifteen cents per 1,000 brick. Cartage costs about twelve to fifteen cents for 100 feet. Another item of expense in procuring the material is the tempering sand. Many obtain this on their premises, while others obtain it from Jones' Point, Wilber on Rondout Creek, or Marlborough. That from Jones' Point is especially good for tempering, containing probably a large amount of iron. Those

yards which have to bring their tempering sand from a distance have to pay from forty to sixty cents per cubic yard for transportation. At most of the yards below Catskill which have the sand on their premises, it is often mixed with coarse gravel and cobblestones, necessitating screening before use.

There are three chief kinds of clay used for making bricks, viz.:

*1. Pure clay. Mostly Al. and Si. in varying proportions, with a small percentage of salts of Fe., Ca., Mg., etc.

2. Loam or sandy clay.

3. Marl. Containing a large amount of lime.

Those of the Hudson valley belong to the third class.

The London brickmakers add lime and ashes or breeze for fluxing and to prevent shrinking. Such admixtures affect the color of the brick. The color of the brick is largely determined by the hydrated oxide of iron, and also by the degree of heat used in burning. Lime produces a cream-red color if present in sufficient quantity. Magnesia also tends to stop the development of the red color. †Page states that "the admixture of a proportion of siliceous sand, which results in a combination containing as much as 90% Si., is not incompatible with the formation of a good brick." To make an even and average brick there should not be any small pebbles or grit in the tempered material. Clay that has been weathered makes a better brick. Oxide of iron gives the brick hardness and strength. Silicate of lime makes the brick fusible and causes it to soften and often become distorted in burning. Quick lime slacks and absorbs moisture, prevents adherence of the mortar and promotes disintegration. Uncombined silica, if not in excess, is beneficial, as it preserves the form at high temperatures. In excess it destroys cohesion and makes the brick brittle and weak. An excess of loam, say one-half, makes the brick rotten. This last fact has been proven by experiment at one of the yards.

GENERAL REMARKS CONCERNING BRICKS, AND THE RELATIVE QUALITIES OF THOSE MANUFACTURED ALONG THE HUDSON RIVER.

When well made, bricks are nearly as strong as the best building stone. The size of the green bricks varies somewhat at the different yards. This is regulated to a certain extent by the char-

* Economic Geology, D. Page, p. 186.

† Encyclopædia Brittanica. Article *Bricks*.

acter of the clay. Strong clay which absorbs a large amount of water in tempering and has to be molded a large size, as it shrinks greatly when drying and in burning. In fact sometimes bricks from strong clay shrink so much as to become undersized. This does not lessen their strength but a much greater number are required for a given amount of masonry. Weak clays absorb little water in tempering and hence shrink little. English bricks are usually larger than the American ones. It is of importance to preserve the corners and edges of the brick.

I. Baker gives the following requisite characters of a good brick.

1. It should have plane surfaces, parallel sides, and sharp edges and angles. The regularity of form depends largely in burning.

2. It should be of fine compact and uniform texture, quite hard, giving a clear ringing sound. The compactness and uniformity of texture, which greatly influences the durability, depends mainly on the method of molding.

Hand machines produce the best brick, soft mud machines the next best.

3. It should not absorb more than one tenth its weight of water. Davis* gives a simple method of testing: "Place the brick in a bucket of water for five minutes or so, and if it absorb over eight ounces reject it." This applies only to hard-burned bricks. Very soft and underburned bricks absorb twenty-five per cent to thirty-three per cent of water.

4. The specific gravity should be twenty or more.

5. Its crushing strength should be 7,000 pounds per square inch. It should have a cohesive force of at least 400 pounds per square inch.

All tempered clay bricks are denser or closer on the inside than outside. The quality of the bricks also depends on the clay used.

METHODS OF MANUFACTURE.

In order to produce a good brick the clay must be thoroughly broken up and well mixed with sand and coal-dust before putting it into the molding machine. The proportions of sand used are from one-fourth to one-third the amount of clay, and about one bushel of coal-dust per 1,000 brick. The sand being added to

*C. T. Davis, bricks, tiles and terra cotta.

counteract the unequal shrinkage due to the alumina, the proportion of it varies with the fatness or purity of the clay.

The quality of the sand is also of great importance, as it furnishes the iron, the bond, which cements the particles of the clay together, forming a hard ringing brick. Many of the manufacturers obtain their clay from Jones' Point, the sand from that locality having the requisite quality. A certain amount of yellow clay, which is found in nearly every bank, is added to aid in the production of the desired red color. Coal is added to produce more heat in burning and to save fuel, the coal igniting and burning when the bricks become heated to redness.

The burning away of the particles of coal leaves small cavities in the brick and lessens its strength somewhat, but the economy in fuel is of much importance.

Two methods of tempering are in use along the river:

1. Soak-pits.
2. Ring-pits.

1. *Soak-pits.*— These are the most used, in fact entirely so at Haverstraw, where some of the best brick made along the river are produced. They consist of a square or rectangular wooden pit, into which the clay, sand and coal-dust are dumped and allowed to stand over night to soak in the water which has been poured over them. The following morning the men shovel the soaked mixture into the machine to be molded.

2. *Ring-pits.*— These are circular pits, twenty-five to thirty feet in diameter, and three feet deep, lined with boards or brick. In this pit there revolves an iron wheel six feet in diameter and so geared that it travels from the center to the circumference and then in again. In this manner the clay is thoroughly broken up and mixed with the sand and coal-dust. The pitfull is thus tempered in about six hours, and the pit holds sufficient for about 30,000 bricks. After the material is tempered, this being done in the afternoon, so as to have it ready for the next morning, the surface of the material in the pit is smoothed by means of a board, so that a thin crust forms on the surface and prevents the underlying material from drying.

In the ring-pit the clay is ground and mixed with the sand much more thoroughly than in the soak-pit; however, when a soft-mud machine of the Wylie or Talcott type is used the ring-pit is not considered necessary.

When soak-pits are used, two men dig the clay in the bank in the afternoon, while a third man levels it off as it is dumped into the pit and also adds the requisite amount of water. He is called the temperer. In the morning the two diggers of the previous afternoon shovel the clay from the soak-pit into the machine.

With ring-pits a similar arrangement is used, the only difference being that the third man mentioned above is employed in the morning in wheeling the clay in a barrow from the pit to the machine.

Usually there are two ring-pits to a machine, so that while the clay is being shoveled from one pit into the machine the other pit is tempering clay for the next day, or, two pits and two machines are used but each pit in this case holds enough material for two machines' daily use.

Molding.— Of the molding machines, four types are in use, viz.: Wylie's, Talcott, Adams and hand machines.

The first three are run by steam and the fourth, as the name indicates, by hand. The Adams consists of a screw revolving at the foot of a vertical shaft inclosed within a rectangular box about six feet high. This screw forces the clay into the press-box. This machine does not mix the clay with the sand and hence has to be used in connection with a ring-pit.

The Wylie and Talcott machines consist essentially of an upright shaft revolving within an iron or wooden box, the shaft bearing knives which break up the sand and clay and mix them together. At the bottom of the shaft are curved arms which force the clay into the press-box from which it is pressed into the molds. The molds which contain six bricks, are put into the rear side of the machine and automatically delivered at the front. The capacity of these machines is about 5,000 bricks per hour. Four men are required to tend the machine. A molder who scrapes off the top of the mold as it is delivered from the machine, and watches the consistency of the tempered clay, to see that it keeps uniform; a mold-lander who takes the mold as it comes from the machine and places it on the truck; a sander who sands the molds before putting them in the machine and a boy to watch the machine and stop it when necessary. Besides this there are four truckmen who wheel the bricks from the machine to the yard where they are dumped on the drying floor by two mold-setters.

In the afternoon these men are employed in "hacking" the bricks and wheeling the dry ones to the kiln.

The bricks when molded are spread out on the floor of the yard to dry, until they are sufficiently hard to be "hacked," that is, piled in double or triple rows about ten courses high until dry enough to be put in the kiln and burned.

Three kinds of yards are used in drying the brick:

1. Open yards.
2. Palette yards.
3. Covered yards.

The first method is the most used, the second next, and the third least.

In the open yard the bricks are spread out on a hard floor in the open air, and left about twenty-four hours before they are hacked. After the day's production of brick have all been spread out, the boy who tended the machine in the morning goes along the rows and stamps them with a piece of board set on the end of a long handle. After this the bricks are turned on edge and again stamped. Then they are again hacked and boards laid on top of the hacks to protect them from the rain.

The disadvantage of open yards is that the bricks are exposed to the rain, and if a shower comes up and they are not sufficiently dry to be hacked they become washed, getting a rough, uneven surface. Washed brick are quite as strong as the others, but do not sell for within fifty to seventy-five cents per 1,000 of the others. The washed brick amounts to about fifteen per cent of the whole production.

Covered yards have no washed brick, but the bricks do not dry quite as fast. The roof and sides of the covered yard open in sections, permitting the sunlight to enter, and when it storms the yard can be closed.

The drying floor is of bricks set on edge and covered with sand. It slopes towards one end or from the middle towards both ends, for the purpose of drainage. The floor has to be scraped once or twice a week and rolled occasionally to keep it in good condition.

Drying by palettes. By this method the bricks are taken directly from the machine and dumped on the palettes, which are pieces of board large enough to hold six bricks. These palettes are then set on racks or cribs till the bricks are sufficiently dry to be set up in the kiln. By this method the bricks are kept under

cover and protected from washing. The bricks take somewhat longer to dry, but the capacity of the yard is increased.

Again, the bricks after being put on the palettes do not have to be handled again until set up in the kiln. There is, of course, the expense of setting up the drying cribs. The clay has to be molded somewhat stiffer by the addition of a larger proportion of sand, to enable the bricks to hold their shape while drying, as there is no means of spadding them as in open yards.

However, a palette-squarer has recently been invented by Mr. Swain, superintendent of the Croton Brick Company, which squares the bricks. [See detailed account of the yards.]

Burning.—When the bricks are sufficiently dry they are set up in arches, several of which go to make up a kiln, and burnt. Burning the bricks is the most important stage in the whole process of their manufacture. As stated above, the bricks are set up in arches, and the number in an arch varies from 35,000 to 40,000. The arches are usually about forty courses high, and the open portion of the arch about fourteen courses. It takes two setters and four wheelers one day to set an arch of about 35,000 bricks, and a kiln is usually made up of about fifteen arches. The bricks above the arch are set three one way and then three on top at right angles. They are kept slightly separated by putting small pieces of clay in between them. The first row of brick on top of the arch is called the tie-course, and the first fourteen courses, including the tie-course, first set on top of the bench are called the lower bench, and the rest of the courses above are called the upper bench. When the arch, lower and upper benches have been set, a brick is laid flat on the topmost bricks. This is called the "raw platting," and then on top of this is laid a burned brick at right angles to it, called the "burnt platting." A wall of two thicknesses of "double-coal" brick is put around the outside of the kiln, and then this is covered with "daub," a mixture of earth and water. The daub is to keep any air from entering the kiln except through the doors of the kiln.

The doors consist of an iron frame about fourteen inches high with an iron plate to close them, and the frames are set in the courses of double-coal brick, in front of the bottom of the arch opening on both sides of the kiln. Double-coal brick have six to seven times as much coal dust in them as the others, and are used

for supplying heat to the outer portions of the kiln which would not receive enough from the arch fires alone.

Double-coal bricks sell for about two dollars and fifty cents per 1,000, and are stamped in various ways, according to the fancy of the owner, to distinguish them. They are not as strong as the other brick.

It takes two men one day to daub the outside of a kiln of about fifteen arches.

The next step after "walling up" the kiln with double-coal brick is to start the fires and burn the bricks. The principle of the process is essentially the same whether wood, coal or oil are used. In the case of coal, grates have to be put in a few inches above the level of the floor, and for oil, burners are needed.

First every alternate brick of the "burnt platting" is stood on end to allow the "water-smoke" or steam to escape as quickly as possible. A fire is then started in the mouth of each arch. When coal is used the fire is started with wood, or gas-coke and wood. The fire should be started on the windward side of the kiln so as to allow the smoke to blow through the arches.

The fire is also started from the other end of the arch, and the two fires are then built up slowly till they meet in the middle. The time of crossing the fires varies; with machine-made bricks the fires should not be crossed as quickly as with hand-made ones. Along the Hudson the time of crossing is from forty to sixty hours. The steam should escape evenly all round the top, and the upper limit of the fire should follow directly on it, the steam acting as a blanket, and its lower limit should be even. It is the duty of the foreman to watch the burning carefully, and increase or ease up the steam in any one arch, according as it is coming off too slowly or too rapidly. The fires are increased until the "water-smoke" changes to a bluish-black smoke, and at this point the fire can be seen at night-time coming from the top of the kiln. The kiln is now "hot" and the bricks commence to shrink or "settle," and all the platting is turned down. Up to this point care must be used to gradually increase the heat. The bricks now get their heaviest heat, and the oxides of iron are changed to the anhydrous peroxide, giving the bricks their red color. If the heat in the arches is too great, the bricks run, stick together or become distorted and

cracked. After the firing has been done the doors are all closed and plastered over to prevent any air from entering.

If the bricks are put into the kiln before they are sufficiently dried, or if they are heated too quickly, they are liable to crack.

As to the action of the coaldust in the brick: At first while the brick contains water, there is no access for the air to the particles of coal. However, as the firing proceeds, the water is driven off leaving the brick porous and allowing the air to enter for the combustion of the coal. Particles of lime and lumps of clay cause a splitting of the brick. Insufficiently burnt brick are called "pale," and sell for three dollars and seventy-five cents per 1,000.

The kiln takes several days to cool, and, when cool, the bricks are put on the scows by means of wheelbarrows, and then shipped to the market. If the kiln shed is not situated along the dock, the barrows are put on a car, which is run down a track to the scow. The time of burning is from five to seven days with wood and four to five days with coal or oil. The cost of burning with wood is sixty to seventy-five cents per 1,000 brick, and with coal the cost of burning is forty-five to fifty cents per 1,000. Burning with wood is the cheapest method as far as implements are concerned. With coal there is the cost of the grates and with oil there is a royalty of $160 to be paid on every burner. The latter is, however, the cheapest method as regards the price of fuel. The great majority of the yards along the Hudson use wood, a few use coal and two or three use oil. With coal and oil the heat can be better regulated than with wood. Another important point is the amount of pale brick produced. Most of the yards along the Hudson burn their bricks in clamps or temporary kilns. In these there is sometimes a loss of as much as 50,000 to 75,000 in a clamp of 500,000 bricks, while in a permanent kiln such as the Wingard, at Kline's yard at Rondout, the amount of pale brick is usually not over 25,000. Mr. Kline says that he finds that the pale brick from the Wingard kiln are much stronger than those from the clamp. Again, in the case of permanent kilns, it takes no more, if not less, time to set the the bricks and there is less daubing to be done. Regarding the amount of labor required in burning, one man is supposed to tend three arches.

DESCRIPTION OF THE HUDSON RIVER CLAY BANI GOING DOWN THE WEST SIDE OF THE RIV FROM COEYMANS LANDING TO HAVERSTRAW, A COMING UP THE EAST SIDE FROM CROTON.

Coeymans Landing. — There are two yards situated at t place, lying next to each other and to the north of the villa The lower one, belonging to Sutton & Sudderly, and worked them and four other parties, lies along the river shore. Th clay is obtained from the bank west of the yard. The clay wh is both blue and yellow, chiefly the former, is of fair quality w few streaks of fine sand. It is worked chiefly with the sho the clay being dug at any convenient point in the bank, a la portion of which was brought down last spring by means dynamite, thus mixing the blue and yellow to a certain exte The clay does not have to be carted over 150 feet to the machin A drive-pipe which was sunk near the owner's barn, which is feet above mean tide and some 300 feet back from the river, show seventy feet of clay and sixty feet of sand. The sand underly the clay is of a grayish-black color, consisting chiefly of gra of quartz and shale, mostly the latter. There are, however, a grains of garnet, epidote and feldspar, and scattered throug are pebbles of quartz, etc., most of them not over an inch diameter. This sand, after being screened, is used for temperi The upper limit of the underlying sand varies; at the north e of the property it rises to within a few feet of the terrace surfa while some 300 feet south of this the clay has been excavated within fifteen feet of mean tide level and the sand has not been reached.

Adjoining the yard of Sutton & Sudderly on the north is tha Corwin & Cullough, sublet by them to T. Finnegan, and Dela & Lavender. The clay, which is obtained just west of this ya has been excavated to seven feet above mean tide and the bott not yet reached. It contains several veins of fine sand. Both and yellow clay are present. At the south end of the yard escarpment of the terrace is of drift material containing sm bowlders. The tempering sand is obtained from this b There are outcrops of yellow clay on the land of Mr. Bronk, the north of Corwin & Cullough's yard; also on the Law property, to the east of the white iron bridge crossing Coeym

creek. This latter locality lies some 800 feet from the river, and would be somewhat more expensive to work. Again, on Main street, just south of the residence of Miss Wolf, there is an exposure of clay, on the hillside, some 400 feet from the river.

Coxsackie.—There is only one yard here, that of F. W. Noble, situated some 700 feet from the river and about a quarter of a mile north of the village. The yard is situated about 100 feet above the river, on a bed of shale, and the clay has not yet been dug below the level of the yard. The clay, which is both blue and yellow, is quite dry and overlain by from one to two feet of loam. The bank, as at present exposed, is some thirty-six feet thick. There is an exposure of blue clay in the escarpment of the terrace, south of Coxsackie.

Athens.—Of the three yards at this locality, adjoining each other about half a mile to the north of the village, only two are running. The one nearest to the village is that of Wm. Ryder, whose yard lies eighty feet above tide-level and some 500 feet from the river. Mr. Ryder owns twelve acres of clay land. The clay, which has not been dug below the level of the yard, runs up to 125 feet above mean tide, and is both blue and yellow, with about six feet of loam on top. A well was sunk eighteen feet below the level of the yard, and the bottom of the clay was not reached. It is mined at this yard by means of plows and scrapers. As this top six feet of loam contains some organic matter it would benefit the brick to leave it out. The clay is quite dry. The bricks when taken from the kiln are sent down to the shore on cars, to be loaded on the scows. Adjoining this yard on the north is that of Mr. Porter, not now in operation. A few hundred feet to the north of this, on the south side of Murder creek, is the yard of I. R. Porter. Although situated near the shore the water is not deep enough to bring the scows up, and the bricks have to be hauled some 200 yards to the dock. This clay bank is also worked by plows, and the machines are run by horse-power.

Catskill.—Alex. McLean's yard is situated on Water street, to the east of the wagon bridge. He owns twelve acres of clay land along the street. The clay is mostly blue, with a few feet of yellow and yellowish-red clay on top, and is about ninety feet thick. The upper portions of the clay are tough and have to be worked with a pick. The clay is underlain by a grayish-black

sand of the same structure and appearance as that at Coeymans, but it contains so much lime as to render it unfit for tempering, causing the bricks to burst when burnt. McLean has to bring his sand from Jones' Point, at a cost of forty cents per cubic yard. The manufacture of drain-tile, hollow brick and sewer-pipe has been attempted with this clay, but was given up, it is said, for financial reasons. Ferier & Golden's yard is situated on the opposite side of the street from McLean's, and their clay bank is practically a continuation of his. Their tempering sand is carted from near the West Shore railroad station, a distance of about three-quarters of a mile. The bricks are burnt with wood, though petroleum was successfully used for a while, but its use was abandoned on account of the odor. The bricks are run down to the dock on cars. Lying along the creek to the north of the bridge is the Derbyshire yard. Most of this yard is covered. The clay is both blue and yellow, and is dug in a rather steep face, causing it to slide often. The blue has been excavated to thirty-five feet above mean tide, and its upper limit is at a height of eighty-two feet, and above this there are twelve feet of yellow clay and three feet of loam. The tempering sand is obtained about half a mile from the yard. As at the preceding yard the bricks are run down to the scows on cars.

Smith's Landing.— The only yard here is that of Theo. Brousseau, having some ninety acres of land.

The clay is mined with the plow, and the tempering sand is obtained from the terrace to the east of the yard. The clay is mostly blue, covered by a few feet of loam. The yard lies some 700 feet from the river, and the bricks are carted down to the dock. Brousseau's property runs back to the West Shore track, and the farms to the north and south of him contain clay.

Malden.— The clay of Cooney & Farrell's yard, to the north of the village, is almost entirely yellow, and lies ten to twenty feet thick on the upturned edges of the Hudson river shales. This yard has just begun operations.

Glasco.— Washburn Bros. This firm has about 150 acres of land, lying mostly along the river, and running back about a third of a mile. The clay is mostly blue. About 130 feet of it are exposed at present. There is about ten feet of light yellowish sand over it, but separated from it by a thin strip of yellow clay. The clay has been excavated to eight feet above mean tide. The

lower third of this clay bank is somewhat sandy, and the best results are obtained by mixing it with the upper two-thirds. At the upper yard the bricks are dried on palettes. A short distance below this on the river is F. M. Van Dusen's yard. The clay lies on the glaciated surface of the shale, and in places is as much as seventy feet thick, and is mostly blue, with several feet of loam on top. Tempering sand is brought from Wilbur, on Rondout creek. J. Porter's adjoins Van Dusen's on the south. The clay lies on a ridge of shale which rises steeply from the shore for some sixty feet. This yard has been but recently started, and not more than eight feet of yellow clay overlaid by about three feet of loam have been excavated by the plows. The clay is carted down to the yard which is built over the river. About a mile below this are the yards of C. H. Littlefield, A. Rose & Co., and D. C. Overbaugh.

The three are close together, the clay lying behind the ridge of slate which rises steeply from the river. The terrace here is 150 feet high, and borings which have been made show a depth of as much as sixty feet. (See table.) The clay is quite dry, and seems of good quality. Palettes are used at Rose's yard. The clay is carted to the edge of the cliff overlying the yard and sent down to the pits on a shute.

East Kingston.— To the north of East Kingston lies the yard of Streeter & Hendrix. This firm and those of D. S. Manchester, Brigham Bros., C. A. Schultz, A. S. Staples, R. Maine & Co., Terry Bros. and W. Hutton get their clay out of the terrace extending from Glasco down to Rondout. At Streeter & Hendrix's yard, the clay lies some 300 yards from the river. For thickness of clay see table. They obtain their tempering sand from Wilbur. Manchester's bank is similar. At Brigham Bros.' yard the clay at present used is yellow, about ten feet of its being exposed.

It lies on an uneven ridge of shale. On account of its toughness the clay at this yard is being worked by undermining, as is the case with other yards along here where yellow clay is being dug. C. A. Shultz has an exposure of clay eighty feet thick, overlaid in spots by sand which can be used for tempering. The bank of A. S. Staples, the next on the south as exposed at present, is somewhat thicker owing to its having been excavated deeper. The clay is underlaid by hardpan. At R. Maine & Co. the terrace is quite narrow,

due to the ridge of limestone approaching the river, and at Terry Bros'. yard the clay (mostly blue) has in many spots been removed sufficiently to show the underlying glaciated surface of the limestone. At Hutton's yard the blue clay is exposed from eight feet above tide to 110 feet; above this there is about ten feet of yellow, and over this about fifteen feet of sand. It will be seen from the limits quoted above that the thickness of the clay between Glasco and Rondout varies considerably, amounting to 120 feet in places, and in others not over twenty feet. This is owing to the great irregularity of the underlying rock surface.

Port Ewen.— At S. D. Coykendall's yard there is considerable fine sand present, and the clay slides considerably. It is dug at any convenient point in the bank. The clay is overlain by several feet of sand which is used for tempering and molding. Oil is used for burning the bricks at this yard.

J. Kline obtains his clay from various points on the escarpment of the terrace, and in some cases it has to be hauled as much as a quarter of a mile. Mr. Kline has made borings at various points along the river in the vicinity of his yards, and at none of them has he found over eighteen feet of clay. Beneath it was hardpan. This would seem to indicate that the mass of the embankment is hardpan underlain probably by solid rock, and that over this hardpan is a layer of clay, usually blue, and this in turn is overlaid in many places by a moderately fine stratified sand, from eight to twenty feet in thickness.

Roseton.— There is a remnant of a terrace here 120 feet high from which Rose & Co. and J. J. Jover obtain their clay. It is mostly blue, and is found at a height of 100 feet above the river. At Jover's upper yard the clay is underlain by limestone, and overlaid by sand. On top of the clay at the lower yard are ten to fifteen feet of sand and gravel.

A pipe-well from the river level at this yard encountered the following: Eighty feet of clay, twenty-five feet quicksand, seventy feet loose sand and gravel; adding to this the height of the clay above mean tide gives us a total thickness of 180 feet of clay. At Rose's yard adjoining Jover's on the south a well was sunk 135 feet through the clay, and adding to this 108 feet of the clay above mean tide gives a thickness of 243 feet at this point. The terrace extends back several hundred feet into a re-entrant angle formed by

the limestone which occurs along the river at this locality. The clay, which contains little fine sand, is worked in benches, and carted to the pits. To the south of Roseton station there is a bank of sand, of alternating yellow and black layers, which has been used for tempering, but is said not to give as good results as that on Jover's premises.

New Windsor.— There are six yards here, their clay lying under the 110-feet terrace. The clay is both blue and yellow, the former having veins of quicksand, and the yellow being very tough, from ten to twenty feet thick and worked by undermining. The thickness of the clay varies from twenty to sixty feet; the layers are in many places contorted and in some cases have been compressed so as to obliterate the stratification. The clay is overlaid by gravel and sand which is used for tempering. Most of the New Windsor clay permits of the admixture of very little water in tempering. Ring-pits are used at these yards in connection with Adams' machines.

Cornwall-on-Hudson.— The only yard here, that of C. A. & A. P. Hedges, is situated on the West Shore railroad track about half a mile north of the station. They have twenty-seven acres of land. The clay is both blue and yellow, and the main portion of it is overlain by delta deposits of the Moodna River. The clay layers are compressed in places, making the clay tough enough to necessitate its being dug by picks. The bank is worked in benches and the clay has to be carted about 300 feet to the pits. About forty-five feet of clay are at present exposed. The terrace under which it lies is 138 feet high, but the upper half if not two-thirds of it are sand and gravel used for tempering. This yard ships many of its bricks to points on the New York, Ontario and Western railroad.

Haverstraw.— The yards lie mostly along the shore, stretching from the lower end of Haverstraw village, northward around Grassy Point up to the base of Stony Point. A few of them are situated along Minisceongo Creek. Most of the yards along the shore are digging their clay below tide-level. At the south end of the village a dam was built at an expense of $30,000, taking in twelve acres of clay land from the river, the clay being covered by but a few feet of mud. This last-mentioned clay bed is underlain by a bed of glacial material from which is obtained the tempering sand. The clay in this enclosure has been, thus far,

excavated to about twenty feet below mean tide. At the Excelsior Brick Company's yard they have gone thirty-five feet below river-level; at Donnelly & Son's, forty-five feet, and west of Washburn's yard, forty feet. A pipe-well of 100 feet was sunk from river-level through the clay of the Excelsior company's bank, at this depth a bowlder was struck.

The clay in these pits is rather sandy on top, but is said to improve with the depth, although veins of quicksand are always liable to be encountered. In those pits which are being worked along the river there is practically no cost of stripping unless the excavation is widened, but there are two important items of expense, viz.: Pumping the water out of the pits and maintaining the corduroy roads leading into the pits. The clay is dug from any convenient spot within the pit. About quarter of a mile back from the river where the terrace is forty to fifty feet high, clay is being dug to supply the yards of J. D. Shankey, Buckley & Carroll, P. Goldrick, T. Malley, J. Brennan. Some of the yards situated on Minisceongo Creek have to cart their clay 400 to 500 yards. The clay under this terrace, as well as along the shore, where remnants of the terrace are left, is overlain by sand and gravel, sometimes as thick as ten feet, which is screened and used for tempering. Mr. Hedges, of the Excelsior company, stated that next year they intend to obtain their clay by dredging in the river. All the yards at Haverstraw use soak pits to temper their clay and burn their bricks with wood. The Haverstraw clay is almost entirely blue. Most of the yards can bring the scows up to the kiln sheds, those that can not do this put the loaded barrows on flat cars and run them down to the dock. The four yards at Stony Point obtain their clay from a large shallow excavation on the west side of the track and to the north of the station. They have to cart the clay from 100 to 300 yards, and when the excavation is widened there is the stripping of three to six feet of sand and cobblestones. Corduroy roads have also to be used in this excavation. One of the firms uses stationary kilns having three walls.

Croton Landing.—A few hundred feet south of Croton station lie the yards of the Anchor Brick Company. They have one yard situated on top of the terrace and the other along the shore. The clay deposit is basin-shaped, and on the terrace, some 400 feet from the river. It is mostly blue and underlain by hardpan

cemented by clay. Having been excavated to forty-one feet above mean tide, borings show an additional depth of thirty-five feet in the center, and the engineer who made them calculates that at their present rate of manufacture they have sufficient material to last them fifteen years longer. There is a stripping of about ten feet of loamy clay and sand to be done, and streaks of gravel are occasionally found in the clay.

The deposit is worked in benches having a long working face, the benches meeting in one point at the end of the pit, from which a single track is laid up to the tempering pits.

Tracks are also laid along the benches, and as the working face recedes the tracks are shifted by crowbars. The cars are brought down to the working face by gravity or an engine, and when loaded are drawn by the locomotive up to the tempering pits. Over these a temporary track is laid while filling them, upon which the cars can be run to facilitate dumping. These cars, containing clay for the lower yard, are run upon a wire-rope haulage-plane and sent down, the empty cars and also those containing sand for the upper yard being sent back on it. The bricks are dried in covered yards and burnt in a special pattern of kiln used at this yard. It consists of two walls about fifteen feet high and some fourteen inches thick. The lower portion containing the doors being several feet thick. The two open sides or ends have to be walled up with double-coal brick and daubed as in the ordinary temporary kiln. The bricks when burnt are loaded on barrows, and these put on a flat car, which is run upon a self-acting plane, which carries them to the river level whence the car is run by gravity to the dock. The tempering sand is dug by a steam shovel at the foot of the embankment on which the upper yard is situated.

The whole arrangement of this yard is very neat and economical. The Croton Brick Company has two yards, an open and a palette yard. They obtain all their clay from the river by means of a scoop-dredge, dumping it into hoppers, which when full are run up an inclined plane upon the shore and dumped. The clay is thus exposed to the weather for several months before being loaded on carts and drawn to the pits.

It costs fifteen cents per cubic yard to put it on shore and ten cents to haul it to the pits. At the palette yard they use a hand-machine to square the green bricks. It consists of two sliding plates of steel, attached to which at right angles are smaller plates,

the height of the brick. Attached to the two large plates are handles. The machine is placed on six brick at a time and by moving the handles the plates press against the soft green brick squaring the corners. A boy can square a pitful of bricks (35,000) in a day with this machine. The tempering material at these yards is obtained from the delta material behind them. One of the molding machines has an attachment which feeds sand into it continuously, leaving only the clay to be shoveled in by the workmen. The molding sand is dried by spreading it over the floor of the kiln-shed in a thin layer, it being said to dry quicker in this way.

W. A. Underhill Brick Company.— This yard is situated near the end of Croton Point. The bricks made at this yard are of very good quality, being used for outsides, and selling for fourteen dollars and fifty cents per 1,000. The bed reaches a height of forty feet above mean tide, and has been excavated to fifteen feet below it. Borings at this depth showed six inches yellow clay, three feet of quicksand through which a spring issues, then two feet of yellow clay and below this blue to an undetermined depth. The clay is overlaid by ten to twenty feet of fine sand, some portions of which make much better brick than others. The clay is worked in benches along the working face of which narrow tracks are laid. The cars are drawn by mules, the tracks running round the tempering pits. This clay is best along the river.

Cruger's, Montrose and Verplank.— The clay banks of these three localities are very much the same, a fairly good clay containing patches of quicksand, and lying in hollows or basins cut out of the bed rock. No special method is used to mine the clay, it being simply dug at any convenient and good spot till rock is struck, and then the bank is attacked at another point. At Verplank in the bank of the Hudson River Brick Company, from which most of the yards obtain their clay, the latter is dug partly in benches and drawn to the yards, a distance of one-half to three-fourths of a mile in carts, or in cars hauled along a track by horses. This bank is overlaid by a fine yellowish sand used for tempering and molding. At Montrose and Cruger's the clay is overlain in places by a moderately fine sand and gravel, cross-stratified in places. The clay in this region varies in thickness from six to fifty feet, reaching in some cases an altitude of seventy feet, as at McConnell & O'Brien's bank, and in others only six feet above

mean tide as in McGuire's bank, where the clay is overlaid by ten feet of sand and coarse gravel, and has been excavated to ten feet below mean tide. At King & Lynch's yard on George Point the clay is brought on cars from the bank to the yard. At most of these yards the carting is down grade. Fisher's clay bank at Cruger's is overlaid by two feet of loam full of rootlets and other organic material. This is used to supply part of the tempering material, the rest being gotten from Jones' Point. Several of the yards at this locality use horse power to run their machinery.

Peekskill.— A short distance below this place at Bonner & Cole's yard the clay shows a depth of eighteen feet, portions of it being very fat. Boring has shown an additional depth of fifty feet in places. It is overlaid by an average of five feet of gravel and cobblestones. Pumps have to be used to keep the excavation dry.

Storm King.— About 1,000 feet north of the station there is a clay deposit, mostly of yellow clay, and underlain by hardpan, worked by Mosher Bros. The bank has slid considerably, but the clay has a thickness of from fifty to sixty feet.

Dutchess Junction.— Some three quarters of a mile north of Storm King the eighty-feet terrace commences, and extends almost uninterruptedly to Dutchess Junction, yielding clay nearly its entire length. The clay has a fairly uniform thickness, the upper forty-eight feet being yellow and the rest blue. The greatest thickness of clay thus far known in this vicinity is at Aldridge Bros.' yard, where a wall of sixty-five feet was sunk through the clay, giving a total thickness of 130 feet at this point. It reaches a similar depth no doubt at other yards along here. The clay is usually covered by gravel, and by sand in some cases sufficiently fine to be used for molding or for tempering. The clay is worked in benches, and the haulage distance is from 200 to 300 feet. At Timoney's yard the clay is covered with scrub oaks and bushes, which necessitates some extra labor in stripping.

At the base of Denning's Point are the yards of Denning's Point Brick Company. The clay lies on either side of the railroad track, about 800 feet north of Fishkill creek. About fifty feet of clay are exposed. It is worked in a rather steep face, and is fairly dry. It is overlain by sand and scrubby trees. The sand

on the point is used for tempering; is not as good for this purpose, however, as that from Jones' Point.

Fishkill.— Harris & Ginley's yard is situated about a quarter of a mile below the town. The clay bank at this yard was formerly quite thick, but, having been worked for fifty years, a small portion only is left. The clay contains layers of quicksand, and is underlain by hardpan and shale. Its greatest thickness is forty-five feet. This firm pays the New England railroad $2,000 a year for the privilege of digging clay.

Low Point.—About half a mile above the station and along the track lies the yard of C. G. Griggs & Co. Their clay bank is about 800 feet east of the yard, and the clay is exposed to a depth of twenty feet, overlain by two feet of loam. One hundred feet farther east sand has been dug at the same level to a depth of eight feet without finding clay. Half a mile south of Low Point station is the yard of J. V. Meade. About twenty feet of clay are exposed, overlain by four to ten feet of sand and stones, which is screened and used for tempering. Following below this are the yards of Dinan & Butler, Lahey Bros., Brockway Brick Company, O'Brien, McConnell & Vahey, and Aldridge & Sherman. The banks of these yards are contiguous to each other, the clay being mostly blue, with a few feet of yellow on top, and over this three to four feet of loam or sand and gravel.

Rhinebeck.— There is clay at this locality, but it is not being worked.

Hudson.— There are two yards at the north end of the town J. Fitzgerald's Sons, situated in a re-entrant curve of the shore, and Arkison Bros. yard some 300 yards from the river, the bricks being carted to the dock. The clay at these two yards is blue and yellow, and from seventy to eighty feet thick, overlaid by two feet of loam and underlain by grayish-black sand. There are occasional veins of quicksand in the clay, which is fairly dry and worked by plows. About 1,000 feet north of Fitzgerald's yard at that of W. E. Bartlett, the clay is of the same nature, in fact, being a portion of the clay deposit forming the terrace extending up to Albany and which is quite broad at Hudson. The bank is now being worked in benches. Scrubby pines cover the terrace at this locality.

Stockport.— The yards of Walsh Bros. and Walsh Bros. & Co. are situated together along the shore about half way betwee-

Stockport and Coxsackie. All of the clay thus far dug is yellow, tough, and the stratification almost obliterated. It is worked by pick. The bank showing thirty feet of yellow clay lies on the hillside some 500 feet east of the yard, and is probably underlain by the sand and gravel which crops out in the escarpment of the terrace behind the yard and is used for tempering.

Stuyvesant.— E. Brousseau's yard is situated about one mile south of Schodack Station in the township of Stuyvesant. The yard lies back from the river at an altitude of sixty feet, necessitating a cartage of a quarter of a mile for the burnt brick. The clay is underlain by hardpan and shale and worked by plows. About sixty feet of clay are exposed, consisting of about equal proportions of blue and yellow. Some 300 feet north of the yard is a bed of stratified sand fifteen feet thick used for tempering.

TABLE No. 1.

LOCALITY.	Owners.	Workers.	Millions of brick produced annually.	Market.	Fuel.	Remarks.
WEST SHORE.						
Coeymans Landing..	Sutton & Suderly	Sutton & Suderly	.....	N. Y. city		
		L. K. Brower	.....	N. Y. city		
		H. Slingerland..... ...	.....	N. Y. city		
		J. A. Brower	.....	N. Y. city		
		M. J. Sutton & Co	30	N. Y. city	Coal..	
	Lawson estate	Corwin & Cullough	4	N. Y. city	Wood.	
Coxsackie	F. W. Noble....	F. W. Noble.....	4	N. Y. city	Wood.	
Athens.....	I. R. Porter.....	I. R. Porter.....	1½	N. Y. city ...	Wood.	12 A. land.
	W. Ryder	W. Ryder	6	N. Y. city	Wood.	
Catskill.....	A. McLean	A. McLean	3½	N. Y. city	Wood.	12½ A. land.
	Ferier & Golden	Ferier & Golden	3	N. Y. city	Wood.	
	Derbyshire Brick Co	Derbyshire Brick Co	.....	.....	Wood.	Just started.
Smith's Dock	T. Brousseau	T. Brousseau	4	N. Y. city	Wood	
Malden	Cooney & Farrell	Cooney & Farrell	1½	N. Y. city ...	Wood.	Just started.
Glasco	Washburn Bros.....	Washburn Bros.....	30	N. Y. & J. city	Wood.	150 A. land.
	F. N. Van Dusen.....	F. N. Van Dusen.....	8	N. Y. city ...	Coal..	
	T. Porter	T. Porter	2½	N. Y. city	Wood.	Just started.
	U. F. & J. T. Washburn.....	U. F. & J. T. Washburn	7	N. Y. city	Wood.	60 A. land.
East Kingston	C. H. Littlefield	C. H. Littlefield	.....	.....	.....	Not started.
	A. Rose & Co	A. Rose & Co	5	N. Y. city	Wood.	12 A. land.
	D. C. Overbaugh.....	D. C. Overbaugh.....	5	N. Y. city	Wood.	
	Streeter & Hendrix.....	Streeter & Hendrix.....	5	N. Y. city ...	Coal..	
	D. S. Manchester	D. S. Manchester.....	8	N. Y. city	Wood.	
	Brigham Bros	Brigham Bros.....	6	N. Y. city	Wood.	
	C. A. Shults	C. A. Shultz	9	N. Y. city	Wood.	A few bricks to R. I.
	A. S. Staples	A. S. Staples.....	18	N. Y. city	Wood.	
	R. Maine & Co.....	R. Maine & Co.....	6	N. Y. city	Wood.	5 A. land.
	Terry Bros	Terry Bros	11	N. Y. city	Wood	
	W. Hutton.....	W. Hutton.....	18	N. Y. city	.....	35,000 bricks daily to Kingston.
Port Ewen	B. Turner	S. D. Coykendall	13	N. Y. city	Oil ...	
	J. Cornell estate & S. D. Coykendall	J. Kline	6	N. Y. city	Coal..	
	J. J. Jover	J. J. Jover.	20	N. Y. city	Wood	80 A. land.
	.....	Rose & Co	42	N. Y. city	Wood	40 A. land.

New Windsor	T. Chrystie	J. A. Whitbeck, not running	3	Newburgh	Wood.	Some bricks to New York city.
	E. Walsh	E. Lang	9	N. Y. city	Wood.	
	J. T. Moore	J. T. Moore	5	N. Y. city	Wood.	
	Q. Davidson's Sons	Q. Davidson's Sons	5	N. Y. city	Wood.	
	Moore & Lahey	Moore & Lahey	2	N. Y. city	Wood.	
	D. Carson	D. Carson	5	N. Y. city	Wood.	Covered yard.
Stony Point	T. Tompkins & Son	C. A. Marks	7	N. Y. city	Wood.	
	T. Tompkins & Son	Riley & Clark	10	N. Y. city, ⅝	Wood.	Stationary kilns.
	T. Tompkins & Son	Riley & Rose	10	N. Y. city, ⅝	Wood.	One-third go to Newark.
	T. Tompkins & Son	Allison, Wood & Allison	6½	N. Y. city	Wood.	
Haverstraw	F. De Noyelles	H. Christie	8	N. Y. city	Wood.	A few to New Jersey.
	F. De Noyelles	J. Felter	8	N. Y. city	Wood.	
	F. De Noyelles	P. Lynch	4	N. Y. city	Wood.	
	F. De Noyelles	Shankey, Kelly & Benn	4	N. Y. city	Wood.	
	Denton, Fowler & Son	Denton, Fowler & Son	12	N. Y. city	Wood.	
	Excelsior Brick Co	Excelsior Brick Co	10	N. Y. city	Wood.	
	T. Frederick and estate of J. W. Gillis	T. Frederick	7	N. Y. city	Wood.	
	J. E. Ackerson estate	A. Donnelly & Son	4	N. Y. city	Wood.	
	J. E. Ackerson estate	T. Maguire & Sons	8	N. Y. city	Wood.	
	J. E. Ackerson estate	Murray & Morissey	4	N. Y. city	Wood.	
	J. E. Ackerson estate	G. I. Sherwood	4	N. Y. city	Wood.	
	M. A. Archer	G. Archer	4	N. Y. city	Wood.	
	E. Snedeker	Snedeker Bros	3	N. Y. city	Wood.	
	Estate M. A. Archer	C. D. & G. Archer	11	N. Y. city	Wood.	A few to N. Jersey and N. England
	B. J. Allison & Co	B. J. Allison & Co	10	N. Y. city	Wood.	
	Allison, Wood, Keenan & Co	Allison, Wood, Keenan & Co	5½	N. Y. city	Wood.	
	Wood & Keenan	Wood & Keenan	5½	N. Y. city	Wood.	Covered yard.
	C. L. Scott	Bennett, Rowan & Scott	18	N. Y. city	Wood.	Palette yard.
	Fowler & Washburn	Fowler & Washburn	10	N. Y. city	Wood.	Clay hauled one-half mile.
	E. G. Reed & Haverstraw Clay and Brick Co	Diamond Brick Co	50	N. Y. city	.....	
	S. L. Palmer (yard)	Kelly & Byrnes	4	N. Y. city	Wood.	
	E. G. Reed (clay)	.....	.....	.....	Wood.	
	T. C. Maguire	T. C. Maguire	.....	.....	Wood.	
	M. F. & L. H. Washburn	M. F. & L. F. Washburn	6	N. Y. city	Wood.	
	U. F. Washburn & S. L. Palmer	Washburn & Co	25	N. Y. city	Wood.	
	A. B. Reed	Carr & Smith	8	N. Y. city	Wood.	
	F. P. Felter	Morissey & Co	7	N. Y. city	Wood.	On Minisceongo Creek.
	F. P. Felter (clay)	P. Brophy	3	N. Y. city	Wood.	
	A. B. Reed (clay)	.....	.....	.....	.....	
	J. E. Ackerson	Dolan, Dunn & Butler	4½	N. Y. city	Wood.	
	T. & G. Peck	T. & G. Peck	18?	N. Y. city	Wood.	Palette yard; stopped.
	Lilburn estate	T. Malley	4	N. Y. city	Wood.	On Minisceongo Creek.
	Lilburn estate	P. Goldrick	4½	N. Y. city	Wood	On Minisceongo Creek.
	T. G. & J. Peck	T. & G. Peck & Co	9?	N. Y. city	Wood.	Some bricks to N. J. towns.
	I. Halstead	.....	.....	.....	Wood	
	Lilburn estate	Buckley & Carroll	6	N. Y. city	Wood	
	Lilburn estate	T. Clark	4	N. Y. city	Wood	
	Lilburn estate	J. Brennan	3?	.....	Wood.	

TABLE No. 1—(*Continued*).

LOCALITY.	Owners.	Workers.	Millions of brick produced annually.	Market.	Fuel.	Remarks.
Haverstraw	Lilburn Estate	P. Ohler	3?		Wood.	
	D. Fowler, Jr. & Washburn	D. Fowler, Jr. & Washburn	6	N. Y. city	Wood.	
	A. B. Reed	J. Shanky & Son	4	N. Y. city	Wood.	
Thiells	E. W. Christie	Felter & Mather	4	Patterson & Passaic	Wood.	
EAST SHORE.						
Croton Landing	Anchor Brick Co	Anchor Brick Co	16	N. Y. city	Coal.	
	Croton Brick Co	Croton Brick Co	30	N. Y. city	Wood.	
	W. A. Underhill Brick Co	W. A. Underhill Brick Co.	15	N. Y. city	Coal.	
Crugers	Douglass	C. Carman	4½	N. Y. city	Wood.	
	Douglass	W. H Fisher	3½	N. Y. city	Wood.	
Montrose	Mrs. Bellefeuille	Lynch & King	10	N. Y. city	Wood.	
	O. & C. Frost	O. & C. Frost	6	N. Y. city	Wood.	Covered yard.
	Montrose Pt. Brick Co	Montrose Pt. Brick Co	7½	N. Y. city	Wood.	Palette yard.
	A. Rose	C. Hyatt	2½	Harlem R. R.	Wood.	Transp. by rail.
	J. Morton	J. Morton	4	N. Y. city	Wood.	Transp. by rail.
Verplank	Avery & Blakely	King & Lynch	10	N. Y. city	Wood.	
		A. Fisher	4?			
	T. N. Avery & F. Dane (yard). Hudson River Brick Co. (clay)	T. N. Avery	2	N. Y. city	Wood.	Horse-power.
	Hudson River Brick Co	B. J. Maguire	16	N. Y. city	Wood.	Bricks to West Point this year.
		J. Morton	5?		Wood	Outside brick-covered yard; horse-power.
	C. H. Jones	S. Travers	5	N. Y. city	Wood.	
	C. H. Jones	McConnell & O'Brien	4	N. Y. city	Wood.	One-eighth mile haulage.
Peekskill	C. Southard estate	Cole & Bonner	4½	N. Y. city	Wood.	
	C. Pierce	Oldfield Bros.	4	N. Y. city	Wood.	
	Bonner Brick Company	Bonner Brick Company	10	N. Y. city	Wood.	Two miles below Peekskill.
Storm King	P. Mosher	Mosher Bros.	3	N. Y. city	Wood.	
Dutchess Junction	T. Timoney	T. Timoney	10	N. Y. city	Wood.	One mile below Dutchess Junction; 1,500 feet front.
	T. Timoney	Carman & Denton	10	N. Y. city	Wood.	
	Gurnee	L. Van Buren	12	N. Y. city	Wood.	40 A. land; 450 feet water-front.
	T. Aldridge	Covert Bros.	3½	N. Y. city	Wood	250 feet front.
	T. Aldridge	Aldridge Bros. & Co	17	N. Y. city	Wood.	800 feet front.
	T. Aldridge	Barnacue & Dow	9	N. Y. city	Wood.	700 feet front.